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ROENTGEN DIAGNOSIS OF CANCER OF THE ACCESSORY SINUSES

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The clinical symptoms and examination may be sufficient to permit a diagnosis of cancer of the accessory sinuses, but generally when these symptoms are sufficiently clear the disease is far advanced and hopeless. Early diagnosis and thorough skilful treatment at the beginning are essential for progress. Generally speaking, the diagnosis is made late, and the results obtained by every form of treatment have been discouraging. Generally, it is advisable to combine the information obtained by taking a careful history, performing a careful physical examination and making a careful study with the roentgen rays. It should be the aim of radiologists to obtain the greatest possible amount of detail in roentgenograms taken at various angles that will best show soft tissue effects and yet include bone detail. An ordinary posteroanterior view, including the whole head, and a lateral view made by means of the Potter-Bucky diaphragm are always essential but are only useful for general orientation. Films made to include such large areas do not usually contain enough detail to permit differentiation between benign and malignant disease except in advanced stages.

The interpretation of the evidence of disease in the early stages is difficult. One can suspect cancer from opacity of any localized areas, but one cannot make a diagnosis on this evidence. Other evidences of hyperplastic sinusitis are commonly associated with carcinoma, and a purulent discharge is practically always associated. If one can show destruction of the walls of the sinuses, together with opacity or expansion of the cavity, the diagnosis then becomes less difficult, but that observation means that the condition is advanced. Doubtful lesions should be examined with biopsy.

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DIAGNOSIS

The symptoms generally associated with nasal and paranasal neoplasms should be familiar to the roentgenologist. As Dr. Ross Golden has said, "The first step in the diagnosis of a disease is to think of it." Thus, the radiologist should be thoroughly familiar with the history in each case, and in reading films routinely he should think of cancer. One or many of the following signs and symptoms should suggest cancer of the nasal and paranasal cavities.

1. A sense of fulness in the nose—partial or complete nasal obstruction, usually unilateral.

2. Nasal discharge—either mucopurulent or serosanguineous.

3. Pain—headache if the superior anatomic section is involved and neuralgia if the alveolus or the floor of the antrum is involved or if the fifth nerve or its branches are involved. Pains may be referred to the teeth, simulating toothache. Tumors originating in the middle anatomic section frequently produce paresthesia or anesthesia of the cheek.

4. Fetid odors, if necrosis or ulceration is present.

5. Change of the nasal tones of the voice, due to nasal obstruction or blocking of the antrum.

6. Loss or alteration of the sense of smell.

7. In late stages, expansion or destruction of bone, due to pressure atrophy or invasion by the tumor, with swelling of the face, swelling of the alveolus and loss of the teeth.

8. Invasion of the orbit producing such signs as exophthalmos and proptosis.

9. Ulceration of the tumor in the naris, giving rise to hemorrhage.

10. Invasion of the skin with edema and later ulceration.

11. Local extension to the base of the skull, with consequent neurologic symptoms.

12. Metastasis to the regional lymph nodes, causing dysphagia and dyspnea.

13. Distant metastases, producing symptoms which vary with the site. Most of these signs and symptoms are encountered late in the disease.

Unfortunately, that is when most patients present themselves for treatment, there being no characteristic symptoms early in the disease. The clinical diagnosis is often obvious; the roentgenologic diagnosis may be characteristic, based on (1) increased density of the sinuses or nares, (2) expansion or destruction of bone and (3) an irregular outline of the soft tissues shown by opaque mediums.

In the early stages, there are frequently no symptoms. Neoplasm may be discovered as an incidental finding in investigating an inflammatory condition. Such diagnoses may be early enough to warrant some optimism as to the results of treatment.

Routine roentgenograms of the paranasal sinuses may reveal clouding of one of the sinuses, about which additional information is desired. Radiopaque material is then introduced.

Sicard and Forestier [1] first introduced iodized oil as a contrast medium. Reverchon and Worms injected thin oil into the maxillary antrum to permit better visualization on roentgenograms. Fraser [2] confirmed their observations. At present, the rhinologist introduces a dilute radiopaque substance (usually 1 part iodized oil to 1 to 4 parts olive oil) into the sinuses and refers the patient for a prompt roentgenologic study. The method of introduction of the dilute radiopaque oil depends on the cavity to be visualized (fig. 1).

Radiopaque Oil Technic.—The antrum is filled, after cocainization and thorough cleansing, by passing the dilute oil through a cannula

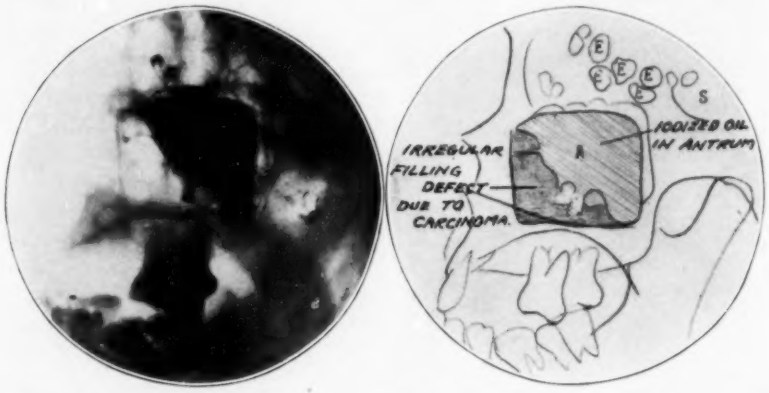

Fig. 1.—Roentgenogram of the sinuses of A. J. H., showing carcinoma of the antrum. There was no evidence of destruction of bone. The diagnosis was based on the presence of an irregular, eccentric filling defect, the remainder of the antrum and the other sinuses being clear, and confirmed by biopsy. In this and the subsequent illustrations, *A* indicates the antrum; *E*, the ethmoid sinuses; *F*, the frontal sinus, and *S*, the sphenoid sinus.

through the inferior meatus of the nose into the antrum. Houser [3] advocated irrigation of the sinus preceding injection, followed by suction to empty it, while Proetz [4] recommended that no fluid be introduced

1. Sicard, J. A., and Forestier, J.: Méthode générale d'exploration radiologique par l'huile iodée (lipiodol), Bull. et mém. Soc. méd. d. hôp. de Paris **46**:463 (March) 1922.

2. Fraser, R. H.: Iodized Oil (Lipiodol) in Otolaryngologic Diagnosis, J. Michigan M. Soc. **25**:270 (June) 1926.

3. Houser, K. M.: Diagnosis and Treatment of Primary Malignant Neoplasms of the Maxillary Sinus, Tr. Sect. Laryng., Otol. & Rhin., A. M. A., 1933, pp. 76-84; Arch. Otolaryng. **18**:643-650 (Nov.) 1933.

4. Proetz, A. W.: Displacement Irrigation of Nasal Sinuses, Arch. Otolaryng. **4**:1 (July) 1926.

into the antrum for twenty-four hours prior to the examination. Roentgenograms are then made with four projections: the posteroanterior (stereoscopically), the Water's, the lateral and the verticomental (or the mentovertical). It is desirable to make at least one of these roentgenograms with the patient in the upright position. Hyperplastic sinusitis produces a uniform concentric narrowing on one or more sides of the cavity. Allergy produces a transitory encroachment on the lumen with

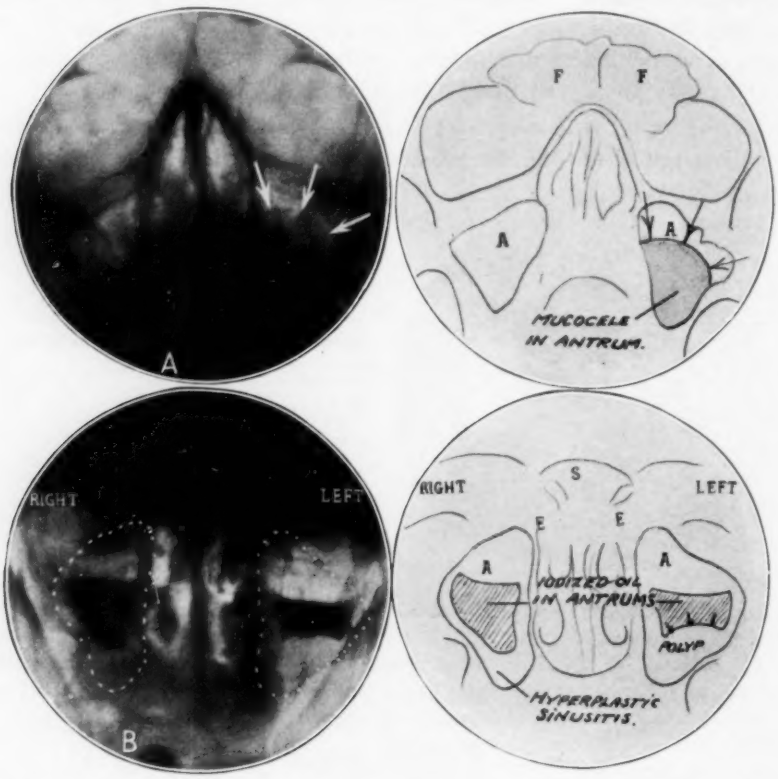

Fig. 2.—*A*, mucocele in the antrum. Note the smooth, curved, soft tissue shadow arising from the region of the floor of the left antrum. The bony walls are intact. The film was made with the nose-chin, or Waters, projection. *B*, film made with the upright Granger, or 7 degrees, projection. Note the fluid level. Iodized oil has been injected in both antrums. Polyps are seen arising from the floor of the left antrum. The thickening of all the mucous membrane of the nasal and paranasal cavities is compatible with hyperplastic sinusitis. The bony outlines are intact.

characteristic lobulated outlines. Mucocele or adenoma produces large, smoothly outlined filling defects usually arising from the floor of the antrum. Polyps produce a single large, smoothly outlined defect or numerous small ones, projecting into the lumen (fig. 2). Neoplasm

produces an eccentric, irregular filling defect. The remainder of the antrum is clear.

Proetz [4] has devised a displacement method which is valuable in visualizing the ethmoid and sphenoid sinuses. This is of more value in differentiating inflammatory lesions and in determining the rate of emptying of the sinuses. The head is placed with the vertex in a dependent position. The dilute iodized oil is introduced into the nares,

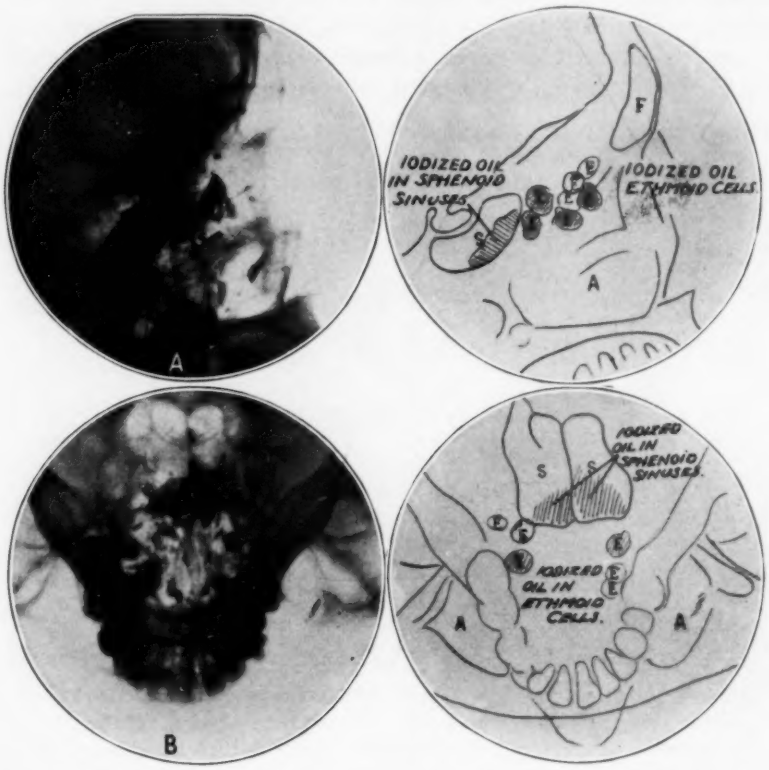

Fig. 3.—*A*, visualization of the ethmoid and sphenoid sinuses after the introduction of iodized oil by the Proetz method. *B*, roentgenogram made in the same case with the verticomental projection.

submerging the ostiums of the sinuses to be examined. Repeated suction with return to atmospheric pressure permits withdrawal of small amounts of air and their replacement with iodized oil. The negative pressure is obtained by the use of a large rubber Proetz bulb, the nozzle of which fits firmly into the nostril. The opposite nostril is held closed, and the patient pronounces the letter "K," which elevates the soft palate and closes the nasopharynx. The ethmoid and the sphenoid sinuses can thus be satisfactorily filled (fig. 3).

Much valuable information can be obtained by the filling of the sinuses, but even more information can be obtained by observing the emptying. The sinuses should be half empty in twenty-four hours and three-fourths empty in forty-eight hours; a trace of the fluid is present seventy-two hours after, and they are empty in ninety-six hours. It can be observed that ample time can elapse, permitting the rhinologist to inject the antrum in his or her office, the patient later reporting to the roentgenologist for examination. The procedure does not require hospitalization or necessitate the rhinologist making the injection in the radiologist's office. One of us (Pfahler [5]) reported a case in which emptying of the antrum was delayed for more than a year, with drainage

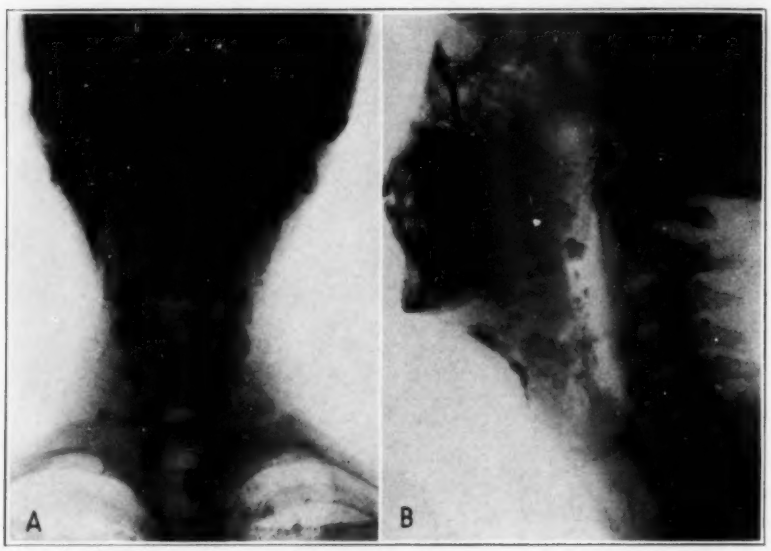

Fig. 4.—*A*, posteroanterior film made two weeks after introduction of iodized oil into the antrums. The opaque oil is apparently in the lymphatics, where it was demonstrable four years later. Note that there is still a radiopaque substance in the right antrum. *B*, lateral projection made in the same case.

of the iodized oil through the cervical lymphatics and into the mediastinum (fig. 4).

In introducing the oil through a trocar, care must be exercised not to puncture the lateral wall and introduce the oil into the soft tissue.

Roentgen Technic.—Among the most important factors in the diagnosis of malignant disease of the nasal and paranasal cavities is the observance of a careful roentgenologic technic, with an adequate number of good films with various projections. We do not wish to become involved in a discussion of the merits or disadvantages of the Potter-

5. Pfahler, G. E.: Demonstration of Lymphatic Drainage from Maxillary Sinuses, Am. J. Roentgenol. **27**:352-356 (March) 1932.

Bucky diaphragm in sinal work. Law stated that excellent "pictures" are produced with the Potter-Bucky diaphragm but that the disadvantages outweigh the advantages. These disadvantages he enumerated as follows: (1) increased distance between the head and the film with consequent increased distortion, (2) a confusing intensification of the structure of cancellous bone and (3) loss of soft tissue detail due to the greater degree of contrast.

Law [6] recommended its use for the verticomental projection. In addition, we think it is necessary for the submentovertical projection of Hirtz and Worms.[7] For the posteroanterior and oblique projections, its use is optional in routine sinal examinations. In the diagnosis of malignant disease of the sinuses, when the appearance of the bony structures surrounding the sinuses is of such diagnostic importance, we recommend the employment of the Potter-Bucky diaphragm.

The following projections are made routinely of the sinuses:

1. Posteroanterior, occipitoglabellar projection; stereoscopic films with the central ray in the following directions: (*a*) through the base line, (*b*) with 10 degrees cephalic angulation of the tube and (*c*) with 10 degrees pedal angulation of the tube.

2. Lateral projection, usually stereoscopic.

In addition, we frequently make exposures with the following projections:

3. Submentovertical projection of Hirtz or

4. Verticomental projection.

5. Waters,[8] or nose-chin, projection.

When additional information is necessary, films are made as follows:

6. Vertical projection with a sphenoid film in the mouth, as described by one of us (Pfahler [9]).

7. Oblique maxillary projection of Pfahler.

8. Rhese [10] or Goalwin [11] oblique projection.

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6. Law, F. M.: Nasal Accessory Sinuses Roentgenologically Considered, in Annals of Roentgenology, New York, Paul B. Hoeber, Inc., 1933, vol. 15.

7. Hirtz, E. J., and Worms, G.: Des "périsinusites" profondes, Ann. d. mal. de l'oreille, du larynx **45**:833, 1926. Hirtz, E. J.: Les signes radiologiques de l'extension des infections sinusiennes profondes à la base due crâine et au mésencéphale, J. de radiol. et d'electrol. **11**:305 (June) 1927.

8. Waters, C. A.: Roentgenology of the Accessory Nasal Sinuses, Describing a Modification of the Occipitofrontal Position, Am. J. Roentgenol. **2**:633 (Feb.) 1915.

9. Pfahler, G. E.: (*a*) The Roentgenographic Study of the Accessory Sinuses, with Special Reference to the New Technic for the Examination of the Sphenoid Sinuses, Ann. Otol., Rhin. & Laryng. **30**:379 (June) 1921; (*b*) in Discussion on Carr, G. L.: Roentgen Ray Findings in Skull in Cases of Brain Tumors, with Special Reference to Porus Acusticus, Am. J. Roentgenol. **4**:405 (Aug.) 1917.

10. Rhese: Die chronischen Entzündungen de Siebbeinzellen und der Keilbeinhöhle, Arch. f. Laryng. u. Rhin. **24**:383-449, 1910.

(Footnotes continued on next page)

ANATOMIC FACTORS INFLUENCING LOCAL EXTENSION AND METASTASES

Hautant,[12] Dechaume [13] and Ruppe [14] divided the nose and paranasal sinuses into three sections:

1. Inferior section—the alveolar process and the floor of the antrum. Tumors within this region metastasize to the submaxillary lymph nodes. They are largely extrasinal in origin and involve the nose and paranasal sinuses secondarily.

2. Middle section—the remainder of the maxilla and the nasal cavity at the same level. Tumors in the second and third sections metastasize to the retropharyngeal nodes. This middle section includes the region where the nares, ethmoid sinuses and antrums are in close proximity, being separated only by thin bony walls. Lesions which occur in this section therefore generally involve all three areas.

3. Superior section—the ethmoid cells, sphenoid sinuses, frontal sinuses and upper nasal cavities. The superior section is separated from the orbits by the thin walls of the ethmoid bones, and involvement of this section is usually associated with invasion of the orbit, with displacement of the eyeball, early in the disease. The cribriform plate offers the only impediment to intracranial extension of the disease from this section.

Öhngren [15] divided the tumors with reference to an imaginary plane extending from the internal canthus downward and posteriorly to the angle of the jaw, the prognosis being influenced by the location of the tumor above or below this plane. The prognosis of tumors situated superior to this plane, he stated, is the more serious. Lesions in the superior and posterior region are in close proximity to the meninges and vessels, with fatal local extension always imminent. Irradiation is usually the only treatment which can be employed above this plane, while irradiation and surgical intervention may be combined for tumors inferior to it. Tumors in the anteroinferior portion of the antrum encroach on the hard palate, loosen the teeth, produce neuralgic pains, invade the nose, expand the cheek and remain relatively accessible to surgical treatment combined with irradiation.

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11. Goalwin, H. A.: The Precise Roentgenography and Measurement of the Optic Canal, Am. J. Roentgenol. **13**:480-484 (May) 1925.

12. Hautant, A.; Monod, O., and Klotz, A.: Les épithéliomas ethmoïdo-orbitaires. Leur traitement par l'association chirurgie-radium. Résultats éloignis, Ann. d'oto-laryng. April 1933, pp. 383-421.

13. Dechaume, M.: Tumeurs hyperplasiques des maxillaires, Progrès méd., Dec. 8, 1934, pp. 1985-1993.

14. Ruppe, C.: Tumeurs malignes des maxillaires, Gaz. d. hôp. **104**:1101 (July 18) 1931.

15. Öhngren, L. G.: Malignant Tumours of the Maxillo-Ethmoidal Region, Acta oto-laryng., 1933, supp. 19, pp. 1-476. Treatment of Malignant Tumors of Upper Maxilla and Ethmoid Bone in Sabbatsberg Ear Clinic, Nord. med. tidskr. **7**:135 (Feb. 3) 1934.

LYMPHATICS OF THE NASAL AND PARANASAL SYSTEM

The lymphatic drainage of the floor of the antrums, alveoli and hard palate is to the submaxillary nodes. The frequency of metastasis to these regional lymph nodes is about the same as with squamous cell lesions in the mouth. In a previous publication by us (Pfahler and Vastine [16]), in a series of 111 cases of intraoral squamous cell carcinoma, there were palpable nodes in 82 cases, in 66 of which, judging by surgical reports, the nodes were neoplastic, approximately 60 per cent of the patients having metastases at the time of presenting themselves for treatment.

The lymph channels of the frontal sinuses, the sphenoid sinuses, the ethmoid cells and the upper portion of the antrums drain into the nose. The first station is to the choanal plexus and thence to the regional

Fig. 5.—*A*, photograph of Miss M. S., aged 15, made on March 1, 1937. Squamous cell carcinoma was present, arising in the nasopharynx and the right posterior naris and involving the right sphenoid and ethmoid regions. Retropharyngeal metastases had occurred. The secondary lymph nodes were involved in the region of the internal jugular vein. *B*, photograph made on April 3, 1937, showing radiodermatitis with disappearance of the nodes. *C*, the patient at present without evidence of malignant disease, two and a half years after coming under our observation.

lymph nodes, i. e., the lateral retropharyngeal lymph nodes. These are difficult to palpate and cannot be seen, and, unless they are large or especial care is exercised in searching for them, metastases from the sinuses will escape attention (figs. 5, 6 and 7). The second lymph stations are the deep cervical nodes, situated low in the cervical region about the jugular vein, the retromandibular and the submaxillary lymph

16. Pfahler, G. E., and Vastine, J. H.: Radiation Therapy in Cancer of the Mouth with Especial Reference to the Use of Pure Gamma Rays, J. A. M. A. **96:** 664-669 (Feb. 28) 1931.

nodes. In certain types of carcinoma, the primary lesion and the metastases to regional lymph nodes are not manifest, the first presenting evidence of disease being low in the cervical region in the secondary lymph nodes.

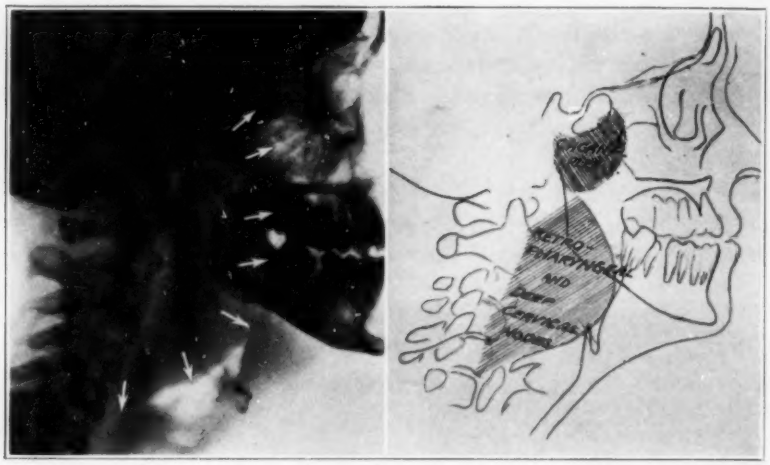

Fig. 6.—Extension to the choanal plexus, retropharyngeal lymph nodes and deep cervical nodes about the internal jugular vein in a patient who recovered under irradiation.

Fig. 7.—*A*, photograph of J. B., carcinoma of the sinuses was present, with metastasis to the secondary lymphatic chain in the deep cervical chain along the jugular vein. *B*, same patient a year and a half later. He is well at present, ten years after irradiation for carcinoma of the sinus with metastasis.

Cancers involving the alveolus, the palate and the floor of the antrum metastasize with much greater frequency than similar lesions above this level. We found metastasis in 60 per cent of 111 intraoral lesions.

Ringertz,[17] in 119 cases of squamous cell carcinoma growing intranasosinally, found 26.9 per cent of the lesions to have metastasized. Quick [18] found 7.3 per cent to have metastasized in 136 cases of carcinoma of the nasal and paranasal sinuses, and Pichler [19] reported 8.8 per cent metastases in 125 such cases.

Metastases may occur, for instance, to the lungs, liver or suprarenal glands without recognizable evidence of involvement of the regional lymph nodes. Ewing [20] reported 2 such cases. Distant skeletal metastases occur infrequently.

CLASSIFICATION ACCORDING TO HISTOGENESIS, WITH THE CLINICAL CONSIDERATIONS AND ROENTGENOLOGIC MANIFESTATIONS OF THE VARIOUS GROUPS

We are radiologists, not pathologists, and, therefore, in the grouping of our cases we have been dependent on the pathologists' reports. These pathologists often employed widely varying classifications. We have tried to use the classification recommended by Ewing,[20] making it conform as closely as we could to the classifications employed by Ringertz [17] and also by Geschickter.[22] A statistical analysis of our own cases based on such varied pathologic reports would be of little value. We have, therefore, chosen characteristic cases to illustrate the different pathologic groups and to emphasize the differential points. For statistics, we are dependent on large series of cases analyzed by pathologists and rhinologists such as the series reported by Ringertz,[17] by Geschickter,[22] by Öhngren [15] and Ahlbom.[23] We have followed and refer the reader to the groups in Ewing's [20] book.

Papillary Carcinomas.—This group constitutes a relatively small percentage of the total neoplasms of the nasal and paranasal cavities. These tumors occur in adults. There is usually a history of long duration, with repeated removals of polyps which eventually are found to be carcinomatous. The nasal cavity is the most frequent site. The adjoining

17. Ringertz, N.: Pathology of Malignant Tumors Arising in the Nasal and Paranasal Cavities and Maxilla, Acta oto-laryng. 1938, supp. 27, pp. 1-405.

18. Quick, D.: Treatment of Malignant Growths of Nasal Accessory Sinus and Nasopharynx, Radiology **14**:191-196 (March) 1930.

19. Pichler, H.: Zur Behandlung bösartiger Oberkiefergeschwülste, Arch. f. klin. Chir. **167**:769-775, 1931.

20. Ewing, J.: Neoplastic Diseases, Philadelphia, W. B. Saunders Company, 1931.

21. This footnote has been deleted.

22. Geschickter, C. F.: Tumors of the Nasal and Paranasal Cavities, Am. J. Cancer, **24**:637-660 (July) 1935.

23. Ahlbom, H. E.: Mucus- and Salivary Gland Tumours, Acta radiol., 1935, supp. 23, pp. 1-452.

sinuses ultimately become involved by extension. Ringertz [17] reports a case in which a recurrent lesion invaded and destroyed a portion of the palate. Clinically, the symptoms are those of nasal obstruction. There is a mucopurulent discharge.

Roentgenologic Manifestations: The nares are both opaque, being filled with the neoplasm. The septum is displaced. The thin medial wall of the antrum is invaded and destroyed. This can probably best be demonstrated by the Waters [8] and the Caldwell [24] projection.

The ethmoid cells, when invaded, are opaque; the cell outlines are lost, and the lateral walls of the ethmoid sinuses may be slightly expanded.

There is interference with drainage due to the nasal obstruction over a long period and consequent clouding of the sinuses not infiltrated by the malignant tumor.

The most important roentgenologic findings with this type of carcinoma are the opacity of the nares and sinuses (which, of course, is not characteristic) and the evidence of destruction of bone, which does not occur with benign papillomas or polyps. A long history of polyps and their repeated removal and recurrence correlated with these two findings should greatly facilitate the establishment of a correct diagnosis.

Squamous Cell Carcinoma (Transitional Cell Carcinoma).—This is the most frequently seen type of cancer involving the nares and paranasal sinuses. It constituted 74 per cent of the carcinomas and 62.7 per cent of all the nasal and paranasal malignant growths of Ringertz' [17] series. The incidence is greatest in middle or late adult life. The condition may, however, occur at any age, as evidenced by 1 case in our series, in which it was first observed in a 15 year old girl. Geschickter [22] stated that squamous cell carcinoma rarely occurs in persons under 40 and is most frequent in the fifth, sixth and seventh decades. The duration is usually three to six months before the patient comes under treatment. The antrum is the most frequent site of involvement. In Geschickter's [22] series of 73 cases of squamous cell carcinoma, the antrum was predominantly involved in 50, or approximately 70 per cent. The local growth is large and markedly destructive; it extends widely and readily invades bone. While the antrum is the most frequent site of the primary lesion, extension to adjoining cavities occurs. Of Ringertz' [20] series, the nasal cavity was involved in 49 per cent of the cases; the ethmoid cells, in 43.1 per cent; the alveolar process and the hard palate, in 45.4 per cent; the orbit, in 22 per cent. He found the antrum involved in almost all cases.

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24. Caldwell, E. W.: Skiagraphy of the Accessory Sinuses of the Nose, Am. Quart. Roentgenol. **1**:27-35 (Jan.) 1907; reprinted, Am. J. Roentgenol. **5**:569-574 (Dec.) 1918.

There is a wide variation in the cell differentiation in squamous cell tumors and in different parts of the same tumor. The radiosensitivity, therefore, varies, conversely to the degree of differentiation. Polyposis is present in about a third of the cases of squamous cell carcinoma, but the association of polyposis is less frequent with this type of lesion than with papillary or cylindric cell carcinomas. There is a frequent history, however, of sinusitis, either with or without polyps.

Clinical Considerations: The symptoms are usually those of pressure or obstruction. The naris is obstructed. The sense of smell may be lost (anosmia). There may be ulceration with hemorrhage (epistaxis) or a bloody mucopurulent discharge. A change in the vocal tones occurs. The lateral walls of the antrum are pushed out, with consequent swelling of the face. Later, there is edema of the tissue of the cheek, with fixation and possible ulceration, due to invasion of the tumor cells. If the orbit is invaded, there is exophthalmos or upward displacement of the eyeball. The lacrimal duct may be obstructed, with resulting lacrimation.

Lesions which extend downward through the palate and alveolus produce neuralgic pains and toothache. Many of the patients first consult a dentist because the pain is referred to the teeth. The teeth become loose due to invasion of the alveolus by the tumor tissue, and bulging of the alveolus or palate may occur. There is tenderness on pressure over the antrum.

Puncture of a roentgenologically opaque antrum returns a bloody fluid and no pus.

Examination of the throat and opposite naris usually gives negative results.

Roentgenologic Manifestations: Houser [3] stated that roentgen examination, with or without filling of the sinuses with an opaque oil, frequently does more than any other method to suggest the presence of a growth or at least arouse suspicion of such a lesion.

There is usually homogeneous clouding of the antrum. The posterior and lateral bony walls of the antrum are thick, and, therefore, their destruction is rarely observed roentgenologically. The medial wall is thin and is seen in the posteroanterior films to be destroyed. The naris is filled laterally, and possibly the entire naris is clouded, and the septum is displaced to the opposite side by pressure. The anterior wall of the antrum is thin and frequently bulges. Later the bone is destroyed either by pressure atrophy or invasion of the bone by the tumor or by osteomyelitis resulting from infection which so often accompanies neoplasms in the nasal accessory sinuses.

The anterior wall of the antrum is best demonstrated by the oblique maxillary projection, first described by one of us (Pfahler). Extension downward with destruction of the bone frequently occurs as a result of invasion of bone by the tumor. This invasion should be sought in

cases of neuralgia particularly referred to the teeth. The floor of the antrum also is probably best demonstrated with the oblique maxillary projection or with dental or sphenoid films inside the mouth.

The orbit is invaded through the thin roof of the antrum. The various posteroanterior projections and the oblique projection described by Rhese [10] and later by Goalwin [11] are valuable in demonstrating destruction of the various walls of the orbit.

The posterior wall of the antrum is thick and is rarely destroyed, either by pressure atrophy or by invasion by the tumor, but we have repeatedly observed by the lateral projection either a laminated appearance or a loss of sharpness of this wall.

The maxillary sinus, the ethmoid cells and the naris are all in close proximity, and, therefore, a squamous cell tumor which is primary

Fig. 8.—*A* and *B*, photographs of Mrs. M. H., made on April 11, 1924. Squamous cell carcinoma of the right antrum was present. Note the swelling of the cheek due to expansion and destruction of the lateral wall of the antrum. *C*, photograph made on Feb. 20, 1925, after electrocoagulation and irradiation. *D*, photograph made on Oct. 14, 1927, showing no evidence of disease. The patient died from metastasis thirteen years after first coming under observation.

in one eventually involves all, the exact point of origin being indeterminate. Involvement of the ethmoid cells is manifested by clouding in both the posteroanterior and the oblique projection. The cell outlines, which are normally recognizable in the lateral projection, are lost. By the posteroanterior projection, i. e., the 23 degree projection and the 17 degree, or Granger,[24a] projection, one can see lateral displacement of the wall of the ethmoid bone. The lateral wall of the ethmoid bone, adjoining the orbit, is thin and is, therefore, quickly destroyed by a tumor involving the ethmoid sinuses, with extension into the orbit and resulting exophthalmos (figs. 8, 9 and 10).

24a. Granger, A.: A Radiologic Study of the Paranasal Sinuses and Mastoids, Philadelphia, Lea & Febiger, 1932.

Extension of the tumor into the base of the skull has been observed by us and can best be demonstrated by the verticomental projection, the projection of the base on a sphenoid film placed in the mouth, as described by one of us (Pfahler [9b]), or by the submentovertical projection, described by Hirtz.

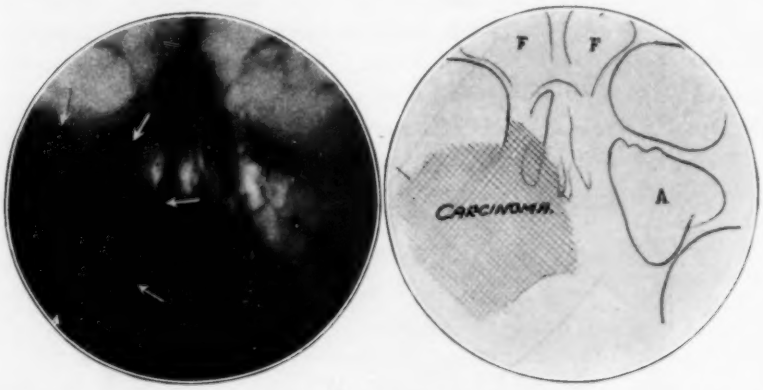

Fig. 9.—Posteroanterior film (Waters projection) of the sinuses of Mrs. M. H., showing squamous cell carcinoma. Note the opacity of the antrum and nares, greater than would occur in inflammation. Note the destruction of the floor of the antrum and the expansion and destruction of its lateral wall.

Fig. 10.—Posteroanterior film of the sinuses of Mrs. M. H., showing a squamous cell carcinoma arising in the right antrum. The floor of orbit is destroyed, with invasion and clouding of the orbit. The lateral wall of the maxilla is destroyed. The medial wall of the antrum is lost, and the disease fills the right naris.

The sphenoid and frontal sinuses are rarely involved primarily by squamous cell carcinoma, the lesion usually being primary elsewhere in the nasal or paranasal cavities with extension to these sinuses. In case of involvement of the sphenoid sinuses, they are clouded; their

outlines lose their clearcut margins, and the Granger [24a] line is lost or is hazy. The Granger line is lost also in the presence of inflammation of the sphenoid sinuses and as a result of pressure atrophy from a pituitary tumor, and loss of the Granger line must, therefore, not be considered pathognomonic of malignant disease of the sphenoid sinuses.

Radiosensitivity: The tumor is moderately radiosensitive. Ringertz [17] reported a 26.0 per cent three year curability and a 20.5 per cent five year curability for this type of lesion. He found a smaller percentage of recurrences with lesions treated by surgical measures (electrocoagulation) plus irradiation than with those treated by surgical measures alone.

Carcinoma of the Basal Cell Type (Salivary Gland Type of Carcinoma).—This type of carcinoma is moderately frequent. It constituted

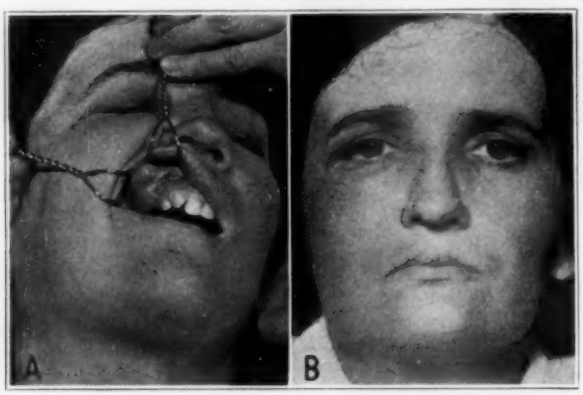

Fig. 11.—*A*, photograph of Mrs. R. J., aged 37. Carcinoma of the basal cell type (salivary gland type of tumor) was present. Note the swelling of the alveolus. The alveolus, hard palate and antrum were invaded. The condition was treated by irradiation only. *B*, photograph of the same patient, twenty months later, showing symmetric facial bones after irradiation. The patient lived over seven years and then died of recurrence. The roentgenograms made in this case cannot be found.

10.8 per cent of the carcinomas and 9.7 per cent of all the malignant tumors of the nasal and paranasal cavities in Geschickter's [22] series. This corresponds closely to Ringertz' [17] series, in which it constituted 9.1 per cent of the carcinomas and 7.7 per cent of all malignant tumors of the nasal and paranasal cavities (fig. 11).

The incidence is greatest in middle or late adult life. The condition may occur at any age from infancy to old age. The average age in 428 cases of the malignant mixed salivary gland type of tumor collected from the literature by Heincke [25] was 49 years. This corresponds closely

25. Cited by Ringertz.[17]

to Paus's [26] series of 76 cases, in which the average age was 48 years, and Ahlbom's [23] series of 254 cases, in which the average age was 52 years. It should be borne in mind that, although the tumor occurs more frequently in adult life, it may occur in childhood or even in infancy (Palma,[27] Wood [28] and Barmwater [29]).

The lesion is slow growing, firm and rather well encapsulated. The duration of the disease before treatment is usually rather long, ranging from several months to several years.

The tumor practically always occurs below Öhngren's line, i. e., in the inferior or lower middle section described by Hautant, Dechaume and Ruppe. The majority occur in the alveolus or hard palate and involve the anterior nasal cavities by extension. Primary involvement is rare in the ethmoid and sphenoid sinuses and has not been observed in the frontal sinus.

Microscopically, the tumor resembles the malignant tumors arising in the salivary glands and elsewhere.

Clinical Considerations: The tumor is firm and well encapsulated. It rarely ulcerates and, therefore, bleeding rarely occurs. There is usually a history of a nasal discharge. Symptoms due to encroachment on the naris appear, such as obstruction to breathing and change in voice. There is swelling of the hard palate and alveolus, accompanied by some pain. As the antrum is invaded and the wall is expanded, swelling of the face occurs, and occasionally this is accompanied by loosening of the teeth. The patient may have first consulted a dentist because of pain and swelling of the alveolus and had several teeth extracted, with relief. Exophthalmos or other displacement of the eye is observed less frequently with this lesion than with other types of carcinoma, although the orbit may be invaded by an extensive advanced basal cell lesion.

Roentgenologic Manifestations: With an early lesion, destruction of the alveolus or hard palate is first observed. The teeth may be surrounded by soft tissue, the bony socket having been completely destroyed. Later there is a homogeneous opacity of the antrum, with destruction of the floor and expansion of the walls, particularly the anterior wall of the antrum, with loss of the bony outline due to pressure atrophy or invasion of bone, best seen by the oblique maxillary projection. The thin medial wall of the antrum is destroyed; the soft

26. Paus, N.: Mischgeschwülste des Gesichts, Beitr. z. path. Anat. u. z. allg. Path. **70**:96-120, 1922.

27. Palma, R.: Riproduzione tardiva di un tumore misto della parotide, Ann. ital. di chir. **5**:577, 1926.

28. Wood, F. C.: The Mixed Tumors of the Salivary Gland, Ann. Surg. **39**: 57 and 257, 1904.

29. Barmwater, K.: Einige Fälle von Endotheliom in der oberen Luft- und Speisewegen, Acta oto-laryng. **16**:1-14, 1931.

tissue tumor can be seen at the periphery of the naris or completely filling it. With hyperplastic sinusitis the naris is obstructed by the enlarged turbinates, which can be recognized roentgenologically, while with malignant invasion the obstruction is seen as a homogeneous clouding of the naris which is not influenced by its structures. The septum is displaced toward the opposite side. The opposite naris and the sinuses not infiltrated are usually clear. These observations are best made by the Caldwell,[24] Granger [21] and Waters [8] projections.

The ethmoid sinuses are occasionally primarily involved and are frequently secondarily involved, with a resulting homogeneous clouding of the entire area, seen by the posteroanterior projections, and with lateral bulging or expansion of the lateral wall of the ethmoid cells and invasion of the orbit. Oblique views with the Rhese [10] projection are of value in the interpretation. The bony outlines of the ethmoid cells, normally seen by the lateral projection, are lost. Encroachment on the air space of the nasopharynx can be recognized in the films made with the lateral projection.

Radiosensitivity: Stewart [25] classified the tumor with regard to radiosensitivity with squamous cell carcinoma of the oral region. Geschickter [22] stated that it is as radiosensitive as lymphoepithelioma, which is highly radiosensitive. Ahlbom [23] found that 15 of 21 such tumors observed by him were either markedly or moderately sensitive to irradiation. Ringertz' [17] material overlapped that of Ahlbom, and he corroborated the latter's finding. Ringertz [17] reported 10 to 17 patients alive three to fourteen years after treatment.

Cylindric Cell Carcinoma (Adenocarcinoma).—Geschickter [22] found this to be a rare form of carcinoma. He included the Schneiderian type of carcinoma in this group, and it then made up only 10.8 per cent of the carcinomas arising in the nasal and paranasal cavities. Cylindric cell carcinomas and adenocarcinomas together constituted the lesion in 12.6 per cent of all Ringertz' [17] cases of carcinoma. The percentage of adenocarcinoma in our series of cases was considerably higher than in either of these. Various pathologists examined the tissue in our cases, and percentages are, therefore, of questionable value.

The incidence is greatest above the fourth decade.

The duration of the condition before treatment is several months to several years, although the exact time of malignant changes is uncertain, since there are associated polyps and a history of frequent removal of polyps over a period of years in a high percentage of the cases.

The growth resembles a polyp or adenoma in appearance and is usually nasal in origin, that in 13 of 15 cases of Geschickter [22] arising from the nasal mucosa. Differentiation, clinically, may be suggested by the irregular, ulcerated surface of the polyps which have undergone malignant changes. They are friable and bleed easily when manipulated.

Cylindric cell carcinoma is a rapidly growing tumor which usually extends widely, filling the naris, destroying bone, invading several of the sinuses and expanding the walls; it involves the middle and superior sections described by Hautant and others. The most common site is where the ethmoid region, the antrum of Highmore and the nasal cavity adjoin.

Clinical Considerations: Two types of clinical picture are encountered. In one, the tumor apparently arises in otherwise healthy tissue. The duration of symptoms in such cases is short—several months. The adenocarcinomas secrete mucus, and there is a rather profuse mucopurulent discharge, amounting to rhinorrhea. Later, when ulceration occurs, this discharge becomes sanguineous.

Since the tumor arises frequently in the middle and superior anatomic sections, erosion through the thin lateral wall of the ethmoid sinuses or the superior wall of the antrum occurs, with invasion of the orbit and early displacement of the eyeball and bulging of the cheek.

In a second type, there is a long history of frequent removal of polyps, which ultimately undergo malignant changes. They are irregular, recur rapidly and extend, filling the naris, bulging the cheek and causing exophthalmos. They are friable and bleed easily. The palate and alveolus may be invaded late in the disease. Pain is mild or absent. Nasal obstruction is one of the first symptoms with either type. Metastasis occurs less frequently than with the other forms of carcinoma. Death is due to local extension more often than to metastasis.

Roentgenologic Manifestations: The roentgenologic picture (figs. 12 and 13) varies with the stage and type of the disease. With tumors occurring in otherwise healthy tissue, the superior nasal meatus is seen to be filled with a homogeneous soft tissue shadow, which early blocks the meatus and causes clouding of the adjoining sinuses, which may be inflammatory or neoplastic.

The ethmoid cells are invaded; bone is destroyed, the cell outlines no longer being recognizable in the films made with the lateral or posteroanterior projections. The thin lateral walls of the ethmoids are at first expanded as evidenced by an increase in the transverse diameter of the ethmoid regions in the posteroanterior films. Destruction of the bone ultimately occurs, and the orbit is invaded. Films in various projections reveal the destruction of bone which is suspected because of the exophthalmos.

The antrum is invaded; the anterior wall is at first expanded and then destroyed by pressure atrophy or infiltration of the tumor. Since the tumor usually arises from the nasal mucosa in the middle and superior anatomic sections, the palate and alveolus are rarely invaded until late in the disease.

The sphenoid sinuses become involved by direct extension. Clouding of the sphenoid occurs, which is sometimes unilateral. The Granger [24a] line is lost. In such cases films should be made with the submentovertical or the verticomental projection or the vertical projection with a sphenoid film in the mouth, because of the great frequency of extension

Fig. 12.— Posteroanterior film of the sinuses of Mr. G. M., aged 60. Carcinoma was present, arising in the left naris and involving the ethmoid sinuses and the antrum on the same side.

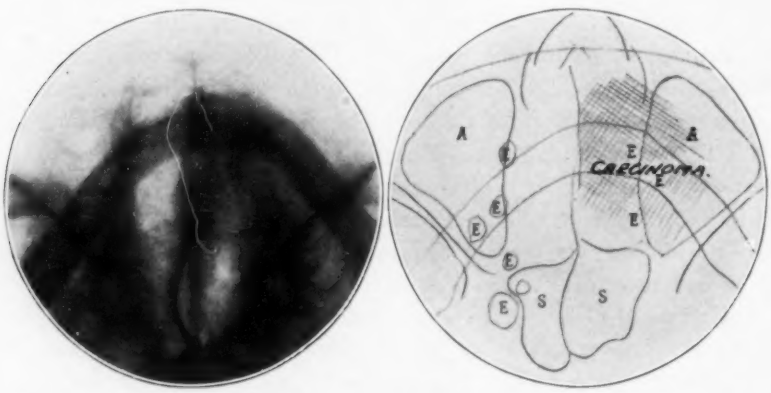

Fig. 13.—Roentgenogram of the sinuses of Mr. G. M., aged 60, made with the submentovertical projection of Hirtz, showing a cylindric cell carcinoma producing clouding in the region where the ethmoid sinuses, the antrum and the naris are adjacent, the lesion being primary in the naris. The patient is living and apparently free from cancer three years after treatment.

into and destruction of the bones of the base of the skull, with intracranial extension.

Radiosensitivity: Cylindric cell carcinoma or adenocarcinoma is only slightly sensitive to irradiation. The site in which it arises and the rapid local extension, producing such widespread involvement

when the patient comes under observation, both preclude successful surgical remvoal, so that irradiation, if not the treatment of choice, is the only possible treatment. In instituting treatment, one should be prepared to reach or exceed the normal tolerance of the tissues for irradiation and even then to be guarded in one's optimism.

Round Cell Carcinomas (Undifferentiated Carcinoma, Transitional Cell Carcinoma, Lymphoepithelioma, Lymphodermal Carcinoma, Schmincke[31] *Tumor, Medullary Carcinoma).*—These terms (Ewing[30]) may not be synonymous, but the conditions which they designate all possess certain characteristics which permit them to be grouped together for radiologic purposes. They are all rapidly growing, highly malignant, undifferentiated tumors, which are consequently radiosensitive. Lymphoepithelioma represented 26 per cent of the malignant epithelial tumors in Geschickter's[22] series. The age incidence is variable. Cases are reported of patients from 14 to 70 years of age. Geschickter[22] stated that there is a predominance in young adults. Such tumors grow rapidly, and the duration before treatment is short, usually not exceeding two or three months. Most of them arise in the posterior naris or nasopharynx. The adjoining ethmoid and sphenoid sinuses and antrums become involved by direct extension.

Clinical Considerations: The primary lesion is often silent. Metastasis occurs so early to the lateral retropharyngeal lymph nodes that the patient is suspected of having an inflammatory disease of the tonsil or tonsils. The tonsils are frequently removed. Later, the secondary lymph nodes in the retromaxillary, submaxillary or deep cervical region become involved, the patient noticing swellings in these regions, the primary lesion possibly still being silent. Dysphagia and dyspnea occur as a result of involvement or marked enlargement of the retropharyngeal lymph nodes.

There is ultimately a mucopurulent or sanguineous discharge from the nose, and one or both sides later become blocked, with resulting changes of voice and loss of sense of smell. Later the eustachian tube becomes obstructed, and pain in the ear develops, with possible otitis media, rupture of the tympanum, otorrhea and deafness. Metastasis practically always occurs.

Roentgenologic Considerations: The radiologist is more concerned with the treatment of such a tumor than with its diagnosis.

The tumor usually arises from the nares or the nasopharynx. The sinuses become involved by direct extension. The ethmoid and

30. Ewing, J.: (*a*) Some Phases of Intra-Oral Tumors, with Special Reference to Treatment by Radiation, Radiology **9**:359-365 (Nov.) 1927; (*b*) Lymphoepithelioma, Am. J. Path. **5**:99-107 (March) 1929.

31. Schmincke; cited by Fitzhugh, W. M., Jr.: Lymphoepithelioma (Schmincke Tumor), Arch. Otolaryng. **28**:376-387 (Sept.) 1938.

sphenoid sinuses are most frequently affected, since the tumor originates in the nasopharynx adjoining them.

The posterior ethmoid cells are involved, and, therefore, they appear clouded, with destruction of their outlines. The lateral walls are not expanded or destroyed, and the orbits are usually not invaded.

The sphenoid sinuses are slightly clouded but probably more from retention of secretion than from infiltration, since destruction of bone is rarely observed.

Extension of the tumor occurs along the lateral wall of the naris, and the thin wall between the naris and antrum is destroyed. This can be clearly demonstrated in films made with the Waters projection. The antrum is clouded late in the disease.

While these changes have been occurring in the nasal and paranasal cavities, the metastatic lesions, both in the first station and in the secondary lymph nodes, have been exceeding the primary lesion in rate of growth and dominating the clinical picture.

Radiosensitivity: The tumors of this group are probably the most highly malignant and, consequently, the most radiosensitive tumors encountered in the nasal and paranasal sinuses. They are so malignant that metastasis has usually occurred before the patient comes under observation, and the prognosis must consequently be guarded.

Schneiderian Carcinoma.—The tumor first described and so named by Ewing[30a] arises from the Schneiderian membrane, the mucous membrane of the nose. It is not uncommon in young persons, although it may occur at any age. The duration before treatment is short. It is a rapidly growing tumor consisting of highly malignant undifferentiated cells. It is highly radiosensitive. It may grow rapidly, invading bone and involving several of the sinuses. Metastasis occurs in a high percentage of cases and may be the first evidence of the disease. Clinically and roentgenologically, this tumor behaves similarly to the tumors included in group 5 of Ewing, discussed in the preceding section.

Connective Tissue Tumors.—Two benign fibromatous tumors, which do not belong in this discussion, are briefly described and illustrated that they may not be confused with malignant tumors. Clinically, they often present problems which are as difficult as those presented by the more malignant tumors.

A. Juvenile Basal Fibroma: This occurs usually in males between the ages of 10 and 25 years. If the patient has survived, the tumors usually regress spontaneously after the patient is 20 or 25 years old. These fibromas arise from the ventral periosteal layer of the embryonal occipital plate. The growth is rapid and expansive, invading the

ethmoid sinuses and completely filling the nasopharynx. The orbit is invaded, with resulting exophthalmos. Extension to the cranium occurs through the cribriform plate.

The tumor is smooth in outline and is lobulated. It is questionable whether it ever undergoes malignant changes. Many authors think not. Dabney,[25] Ewing,[20] Naab[32] and others believe it does.

Roentgenologic Manifestation: The tumor produces dense clouding. A lateral view reveals the filling of the nasopharynx by soft tissue, as evidenced by a smoothly outlined, lobulated area of increased density. The film made with the submentovertical projection reveals marked increase in the density of the base.

The tumor extends and expands bone. There is atrophy of bone due to pressure, but the tumor does not infiltrate the bony structure.

The nares are first affected as evidenced by an increase in density. The ethmoid cells are next invaded. The density is greater than that observed in inflammatory processes. The walls are expanded—the transverse diameter of the ethmoid region is increased, as seen in films in the posteroanterior projection. Calcification is occasionally observed in the tumor, and this is probably a regressive change.

Radiosensitivity: Regression can be effected by irradiation, as evidenced in 2 of our cases, 1 of which is illustrated in this article.

B. Periosteal Fibroma: This is a fibroma with no predilection for age or sex. It arises from the septum, from the lateral nasal wall or, rarely, from the maxillary sinuses or ethmoid. The growth is slow but progressive, ultimately extending to the adjacent sinuses and the base of the skull. Extensive new formation of bone usually occurs, with spicules of bone embedded in the soft tissue tumor, which is termed an ossifying fibroma and often confused with the osteomas.

Fibrosarcoma and Spindle Cell Sarcoma.—These constitute 4.8 per cent of the 846 malignant lesions descriptions of which were collected from the literature by Ringertz,[17] including those in his own cases and in those of Barnes,[33] Davis,[34] Hesse,[35] Geschickter,[22] Harmer[36] and New and Cabot.[37] They constitute 21.6 per cent of the sarcomas.

32. Naab, J. P.: Die chirurgische Behandlung der Nasenrachenfibrome, Beitr. z. klin. Chir. **22**:761, 1898.

33. Barnes, H. A.: Malignant Tumors of the Nasal Sinuses, Arch. Otolaryng. **6**:123-138 (Aug.) 1927.

34. Davis, E. D. D.: Carcinoma of Maxilla and Ethmoid: Survey of Notes of Fifty Cases, Brit. M. J. **1**:53-55 (Jan. 13) 1934.

35. Hesse: Zur Behandlung maligner Tumoren des Hals-, Nasen-, Ohren Gebiete, Ztschr. f. Hals-, Nasen- u. Ohrenh. **31**:233-247, 1932.

36. Harmer, D.: The Treatment of Malignant Tumours of the Upper Air Passages by Diathermy, Acta oto-laryng. **7**:446-470, 1925.

37. New, G. B., and Cabot, C. M.: Curability of Malignant Tumors of the Upper Jaw and Antrum, Proc. Staff Meet., Mayo Clin. **9**:684-685 (Nov. 7) 1934.

The incidence is greatest in middle and late adult life—fourth decade. The tumor grows rapidly, and the duration before treatment is short—several months at most. The most frequent sites are the maxillary and ethmoid bones. The frontal and sphenoid sinuses are rarely involved. The lesion sometimes arises from the surface of the maxillary bone or alveolus, invading the sinuses later. Bone is destroyed, usually by pressure atrophy rather than by infiltration of bone. The tumor is firmly attached to the bone. Microscopic diagnosis is difficult because of the variation of the picture in different sections of the same tumor.

Clinical Considerations: The signs and symptoms are mechanical, as unilateral obstruction of the nose, blocking of the lacrimal duct and swelling and expansion of the nose, cheek and alveolus. Pain due to pressure is sometimes experienced and is neuralgic. Hemorrhage occurs. Metastases occur frequently to the regional lymph nodes, lungs or skeleton (spine).

Roentgenologic Manifestations: Clouding of the naris without regard to the bony structure in the nose occurs. There is hemogeneous opacity of the involved sinus. The lesion progresses rapidly, and, therefore, several of the paranasal cavities may be involved when the patient comes under observation. The orbit is infiltrated, the eye displaced and the soft tissues of the cheek involved. The density, roentgenologically, of the soft tissue tumor is moderate, being greater than that of inflammatory tissue and less than that of such growths as fibromas and osteomas. There is a first expansion of the bony walls of the sinuses and later destruction of the bone due to pressure. The bone appears to dissolve, and the line of demarcation is more pronounced than with carcinoma. A similar clearcut line of destruction of bone is observed with ganglioneuroma involving the orbit. The latter tumor does not arise in the orbit, and although exophthalmos is observed, the sinuses appear clear with it or with glioma.

In cases in which the sarcoma arises from the anterior surface of the maxilla or alveolus, the tumor is firmly adherent to the bone; the underlying bone is destroyed by pressure atrophy or infiltration, usually the former, and there is a smooth, clearcut depression of the bone beneath the tumor.

Metastases should be sought by roentgenograms of the chest and of any portions of the skeletal structure, particularly the spine, if symptoms indicate the possibility of them.

Radiosensitivity: The radiosensitivity of this tumor is low, but usually no other form of treatment is possible.

Osteogenic Sarcoma, Chondromyxosarcoma and Osteoblastic Sarcoma.—These occur relatively infrequently, constituting only 8.5 per

cent of the sarcomas of Ringertz'[17] series. None were listed by Geschickter. They may occur at any age. The patient was 14 in 1 of our cases.

Osteogenous sarcoma is a slowly growing tumor, which becomes bulky and involves the antrum or a sinus, expanding the walls, infiltrating the bone and laying down new bone which soon obliterates anatomic boundaries. Adjoining sinuses become involved, with bulging of the cheek, alveolus and palate and with exophthalmos. The naris is obstructed. Hemorrhage is a late occurrence. Metastasis is rare.

Roentgenologic Changes: The tumor is large and dense and contains considerable calcification. It extends widely, obliterating the cavities, orbit, naris and bony boundaries. When it is viewed tangentially, radiating spicules can be demonstrated. These are particularly well seen in the alveolus or at the anterior surface of the maxilla, as shown by the oblique maxillary projection. The tumor usually arises from some portion of the maxillary bone.

Osteoma.—This lesion is benign and does not belong to the present discussion. It may be confused with osteogenous sarcoma, however, and is, therefore, briefly presented to emphasize the differential diagnostic points. Osteoma appears more frequently than osteogenic sarcoma. It may occur at any age, but is more common in young persons. Eckert-Mobius[38] found it more common in the third decade of life.

In contrast with the osteogenic sarcoma, which originates chiefly below Öhngren's plane, osteoma arises above this plane. Eckert-Mobius[38] listed osteoma as occurring in the following sites: the frontal sinus, 113; the ethmoid sinuses, 53; the sphenoid sinuses, 7, and the antrum, 13. The tumor grows slowly. As a rule, it is not associated with and is not related to inflammatory disease of the nares or sinuses. It rarely produces symptoms other than those related to pressure. It may at times be discovered as a coincidence. We have several patients under observation at the present time whom we examine at yearly intervals to exclude rapid progress.

Roentgenologic Manifestations: The outstanding roentgenologic appearance of the tumor is that of marked radiopacity. The tumor extends moderately but often remains confined to the cavity from which it arises. Over a long period, it may expand the cavity. It is found most frequently in the frontal sinus. Law[6] presented a case in which it arose from a pedicle in the frontal sinus. It filled the sinus, being separated at one stage of its development from the bony wall of the sinus by 1 or 2 mm., the thickness of the intervening mucous membrane.

38. Eckert-Möbius, A.: Gutartige. Geschwülste der inneren Nase und ihrer Nebenhöhlen, Handb. d. Hals-, Nasen-, Ohrenh. **5**:107, 1929.

This gone, the appearance of a dark halo surrounded the dense tumor. When the wall of the frontal sinuses is eroded, it is usually the posterior wall, and a meningocele may thus be established. The size of osteomas is variable. The outline is usually sharp and clearcut, although it may be somewhat irregular.

Myxosarcoma.—Tumors containing mucin are common; many of the different varieties of sarcoma and carcinoma contain mucin between the cells. There are various combinations, such as chondromyxosarcoma and fibromyxosarcoma. True myxosarcoma is probably rare.

It occurs in young people, from infancy to early adult life, although it may occur at any age. Campo [25] reported a congenital myxosarcoma recognizable at birth.

The tumor is slow growing and prone to recur after removal, the history often covering many years, with several surgical removals and several surgical recurrences. It arises in the inferior section, i. e., the maxilla chiefly. The ethmoid cells may become involved. The surface of the maxilla was involved in most of the few cases recorded in the literature. The tumor projects into the cheek or the mouth. The septum is reported as a common point of origin. The ethmoid and sphenoid sinuses are occasionally involved.

Clinically, swelling of the face occurs. There is swelling of the alveolus or palate. Mechanical obstruction of the nose occurs. There may be bulging of the cheek.

Roentgenologic Manifestations: Opacity of the naris or of one of the paranasal cavities can be demonstrated roentgenologically. The tumor is slow growing, and the bone is expanded more than infiltrated. There are alternate areas of sclerosis and atrophy of bone. There may be bony thickening due to periosteal irritation. Tangential films may show periosteal elevation when the anterior surface of the maxilla or alveolus is involved. This is illustrated in the case of a 15 month old child in our series.

Radiosensitivity: The tumor is relatively radioresistant. Regression can be effected or the growth at least retarded, and irradiation should be used in conjunction with surgical intervention, since the lesion practically always recurs after surgical removal alone. Irradiation should be employed cautiously in young children, since retardation of bony growth may occur, which is deforming and may subject the procedure to criticism.

SUMMARY AND CONCLUSIONS

1. To think of the possibility of cancer of the accessory sinuses is the first essential in making the diagnosis.

2. Most diagnoses are made late, and therefore in most cases the condition is incurable.

3. In such a serious disease every possible means of diagnosis must be utilized. This includes the careful taking of the history, thorough clinical observations and a thorough roentgen investigation, with an adequate number of projections and detailed study; finally, a biopsy is essential for the early diagnosis.

4. Cancer involving the accessory sinuses varies in its distribution and characteristics according to the types which we have described. The treatment and management will vary also with these types.

5. In some cases, irradiation alone will give best results. In other types, a combination of surgical or electrosurgical measures and irradiation will give best results.

6. Individual consideration is absolutely necessary in each case, in which the type of disease and its location, extent and duration especially must be taken into account.

NASAL PLETHYSMOMETRY AS A NEW TEST FOR SINUS THROMBOSIS

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The technic [1] here described is based on the fact that compression of the healthy jugular vein while the other jugular vein is obstructed in most cases causes congestion of the wide venous spaces of the nasal turbinates. The swelling of the conchae can be seen in some cases by anterior rhinoscopic examination (fig. 1), but it can be clearly demonstrated in every case by means of a simple apparatus, the nasal plethysmometer (fig. 2).

The nasal plethysmometer [2] consists of two small inflatable rubber balloons, *A* and *B*, each of which is mounted on one leg of a small manometer, *C*. When one of these balloons or both are introduced into the nose, one can blow them up without displacing the meniscuses, by means of the bridge, *D*, while the clip, *E*, is placed on the rubber connection, *F*. When the bridge is closed with the clip, *E*, on the rubber connection, *H*, every variation in conchal swelling will result in a displacement of the manometer fluid.

The instrument can be used in two ways, i. e.:

1. Plethysmometria nasalis unilateralis (fig. 3 *A*), in which one balloon is introduced into the nose on the side where the jugular vein will be compressed first and then into the other side. The apparatus is fixed to the nose with adhesive plaster. This method provides a *sensitive* test, but has the disadvantage that the pulse and respiration are clearly visible.

2. Plethysmometria nasalis duplex (fig. 3 *B*), in which the balloons are introduced one into each nostril. This is a *differential* method, by which the pulse and respiration are not recorded and only the difference between the swelling in the right and in the left nostril is recorded.

The balloons must not be inflated too much, because this will empty the venous spaces. A pressure of 10 cm. of water is sufficient to bring the balloon into close contact with the concha. The pressure by which the jugular vein is compressed must allow a free passage in the carotid artery; otherwise, anemia of the nose and the contents of the skull will follow, with paradoxic results. I was able to show that an effect can

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From the Ear, Nose and Throat Clinic of the University of Amsterdam, under the direction of Prof. Dr. A. de Kleyn.

1. van Dishoeck, H. A. E.: Acta oto-laryng. **26**:53, 1938.

2. Obtainable from Lifa, Breestraat 95, Netherlands.

be obtained with a pressure of 10 cm. of water; with 50 cm. of water one usually has the maximum effect. In order to apply a graded pressure, a special metal collar, mounted on a board with inflatable pads on both sides, was used (fig. 4).

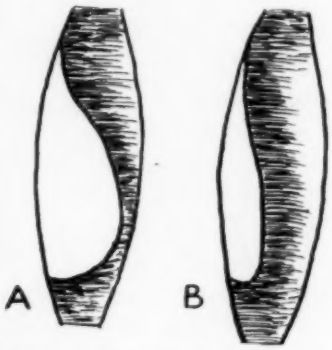

Fig. 1.—Inspection (*A*) during pressure and (*B*) after release; conchal swelling in a case of sinus thrombosis during pressure on the jugular vein of the healthy side.

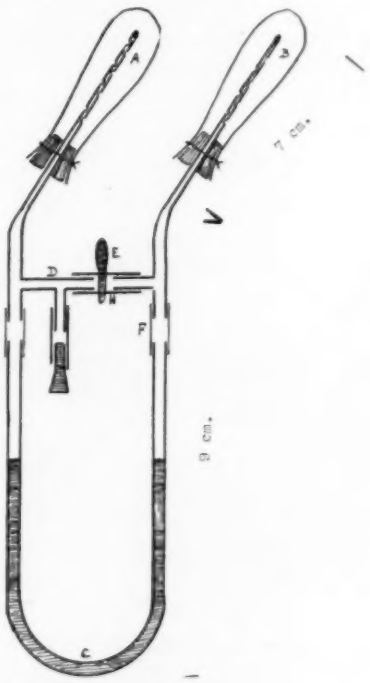

Fig. 2.—Nasal plethysmometer.

In a normal patient, slight pressure on the left jugular vein will cause slight swelling of the left concha and no swelling, or very little, of the right one. Pressure on both jugular veins causes considerable swelling

in both nasal passages. On anterior rhinoscopic inspection, especially, the detumescence when the pressure on the veins is released is clearly seen.

In a case of sinus thrombosis on the left, pressure on the left side of the neck does not produce swelling, while pressure on the right side

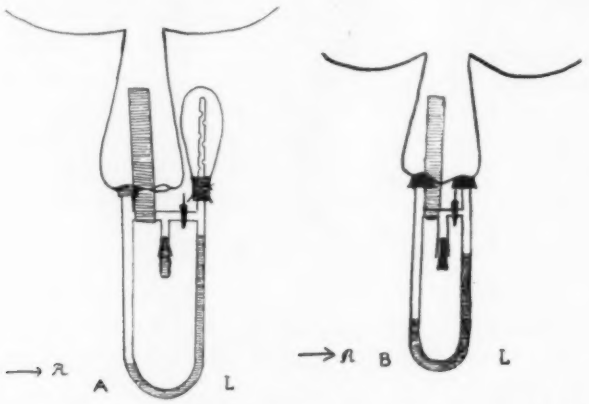

Fig. 3.—*A*, unilateral nasal plethysmometry; sinus thrombosis on the left side; pressure on the right jugular vein. *B*, bilateral nasal plethysmometry; sinus thrombosis on the left side; pressure on the right jugular vein.

Fig. 4.—Nasal plethysmometer with collar.

causes considerable swelling of the right turbinal and a little swelling of the left turbinal.

The positive symptom is thus the marked difference in the conchal swelling when pressure is applied on the healthy and when it is applied on the obstructed jugular vein.

A preliminary nasal examination is neccesary, because the experimental result may be invalidated by the following circumstances:

A. The presence of too little cavernous tissue, on account of nasal crests, operations or atrophy.

B. Previous swelling of the nose to its utmost capacity.

C. Obstruction of the venous connections of the nose and the endocranial system, e. g., in thrombosis of the cavernous plexus.

A definite positive result is diagnostically valuable. Only with congenital aplasia of the sinus is confusion with thrombosis possible.

Conversely, the nasal plethysmometer might be used for detection of the hypoplasia just mentioned. This abnormality is not at all rare. Of 1,022 skulls Luiser [3] found a jugular foramen with a diameter less than 1 mm. in 29; the left side was preferred 5:1. Also, according to Rudinger, in 70 per cent of specimens the left sinus is smaller than the right; in these specimens there is usually little development of the left posterior cranial fossa. When ligaturing the sole functioning jugular vein for pyemia or sepsis, while hypoplasia or aplasia of the sigmoid sinus on the other side was present, Ruttin [4] observed edema of the brain.

A slight difference registered by the nasal plethysmometer is not so indicative; in such cases the possibility of mural thrombosis with a partly patent vessel, of total thrombosis with large collateral veins (fig. 8) and of congenital hypoplasia (left sinus) cannot be excluded. The clinical picture of the disease must be taken very much into account.

RESULTS

Among 16 patients whose sigmoid sinus had been removed from some days to a number of years before examination, the symptom was positive in 13. It is possible that in some of the remaining 3 the sinus had become patent again or that the secondary veins were large enough for the transport of the blood, as has been indicated.

In 7 patients in whom the nasal phenomenon allowed a diagnosis *ante operationem,* this diagnosis could later be confirmed by operation in 6. In 1, however, a marked excursion of the plethysmometer was seen with pressure on the right and on the left as well, but without any difference, while on operation sinus thrombosis was found. It is quite possible that this failure too was caused by the conditions pictured in figure 9. Besides this patient, for 18 other patients with suspected sinus thrombosis the negative result of this test was an additional reason for postponing the operation. Till now these decisions have never been regretted; the findings in later operations or in the further devel-

3. Luiser: Beitr. z. klin. Chir. **38**:642, 1904.

4. Ruttin: Personal communication to the author.

opment of the illness were in the 18 cases not opposed to the interpretation of the nasal phenomenon.

Three cases might be mentioned especially. The first was that of a girl of 17 for whom the decision for a further operation was based solely on the nasal phenomenon, even when previous operations and puncture of the sinus showed no abnormality. This girl had otitis on the right side and a temperature of 40.8 C. (105.4 F.). She presented rigors and a suggestion of nuchal rigidity, and she was non compos mentis. During the mastoid operation, the sinus had been well exposed, and one got the impression that the vessel was normal and well filled; on puncture blood was obtained. On the first day after operation the patient was seriously ill. On the second day she again had rigors; on the third day, vomiting and rigors; on this day pyelonephritis was detected; on the fourth day she again had rigors and herpes labialis; on the fifth day the consulting neurologist found general symptoms suggesting involvement of the cerebrum. Lumbar puncture released clear fluid; the blood picture was toxic. Examination with the plethysmometer yielded the following observations: On pressure on the left jugular vein there was a marked excursion, and on pressure on the right vein no excursion at all was noted. A sinal operation was done and a septic thrombus removed. The girl recovered soon after the operation.

On making a postmortem examination in a second case in which an obstruction was diagnosed by means of the nasal plethysmometer abscess of the temporal lobe of the brain was found and not thrombosis. Also, in another case of abscess of the temporal lobe of the brain the nasal plethysmometer indicated an obstruction. These observations make it probable that this method could be useful also for localization in cases of abscess or tumor of the brain.

A third patient has a fistula of the left ear. In an attempt to demonstrate the symptom of Mygind (i. e., nystagmus on pressure of the vena jugularis), it appeared that on pressure on the left jugular vein nystagmus did not occur but on pressure on the right jugular vein it did. With the nasal plethysmometer, it was found that the left jugular vein was not patent and only the pressure on the right jugular vein registered a result. One might infer that the patient had formerly sinus thrombosis which had not been diagnosed. Probably sinus thrombosis is overlooked in many cases, as this condition does not always produce symptoms (Holderman,[5] Buchband[6]).

EXPLANATION OF PHENOMENON

In order to explain the phenomenon, the following diagrams may be of some use. It must, however, be remembered, that they are only hypothetic and that no experimental evidence can be given.

Figure 5 shows a diagram of the normal outflow of the venous blood from the skull. Most of the blood leaves the skull by way of the jugular veins (*A*). A small part of the blood emerges by way of the secondary venous connections, viz., (1) along the emissary veins and the occipital plexus (*B* and *B'*) and (2) along the connections of the cavernous plexus with the pterygomaxillary plexus (*D*), i. e., through the foramen

5. Holderman, J. W.: Lateral Sinus Thrombosis Without Elevation of Temperature, Arch. Otolaryng. **1**:488 (May) 1925.

6. Buchband, M.: Monatschr. f. Ohrenh. **71**:977, 1937.

ovale, lacerum and rotundum (*C*). The possibility, however, is not excluded that occasionally the blood from the pterygomaxillary plexus and thus from the turbinates (*E*) will partly return to the cavernous plexus.

The external jugular vein (*K*) is of no importance in establishing the nasal phenomenon. This vessel chiefly drains the blood from the external nose. It has also, however, an anastomosis with the deep nasal veins. The amount of blood flowing along this vessel appears to be negligible. In cases in which the internal jugular vein is obliterated and

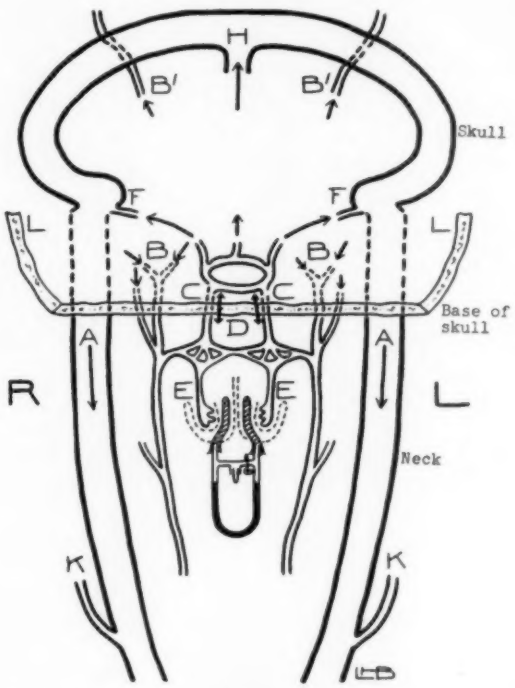

Fig. 5.—Diagram of the normal outflow of the venous blood from the skull.

only the external jugular vein is patent, pressure on this vessel seldom gives rise to a noticeable swelling of the nose. In the study of the problem of venous congestion in jugular compression, the possibility of a rise of the venous pressure in the retinal vessels and a rise of intraocular pressure also has been investigated. Even with compression of both jugular veins, no increase of pressure could be demonstrated by using the dynamometer of Sobrantsky and the tonometer of Schiötz. Spontaneous pulsations of the retinal veins occurred in some cases but not at all constantly.

Figure 6 is a survey of the changes which occur in the case of pressure on the left jugular vein. In this case the blood will find its way

chiefly by the contralateral sinus and jugular vein, while the secondary venous connections, *B* and *C*, too, will receive more blood. The result will be congestion mainly in the left part of the skull. In this way the *left* cavernous sinus and *left* pterygomaxillary plexus will be congested, and the result is a stasis of the blood in the wide venous spaces of the conchae. So the left side of the nasal plethysmometer will be depressed a little.

Figure 7 pictures the changes which occur with sinus thrombosis on the right side if the left jugular vein is compressed. In this case, the

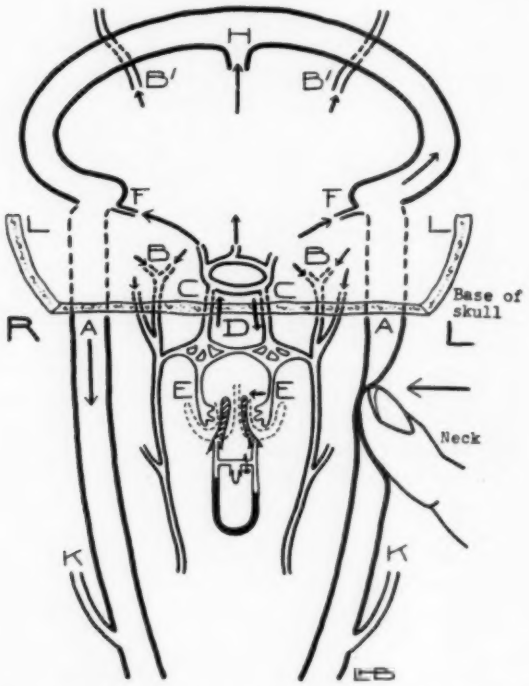

Fig. 6.—Diagram of the outflow of the blood from the skull with pressure on the left internal jugular vein.

secondary venous connections (*B* and *C*) receive all the blood, and a considerable swelling of the turbinates results. One can expect that this swelling will be much more pronounced on the left side, because on the obstructed side compensatory dilatation will have developed.

Figure 8 illustrates an exceptional case. As in figure 3 *A*, sinus thrombosis is present on the right. But in this case, the secondary connections (*B*) are so large that congestion in the cavernous sinus and pterygomaxillary plexus does not result from the pressure on the left jugular vein. Hence, no difference in the excursion of the nasal plethysmometer is produced by pressure on the right and on the left

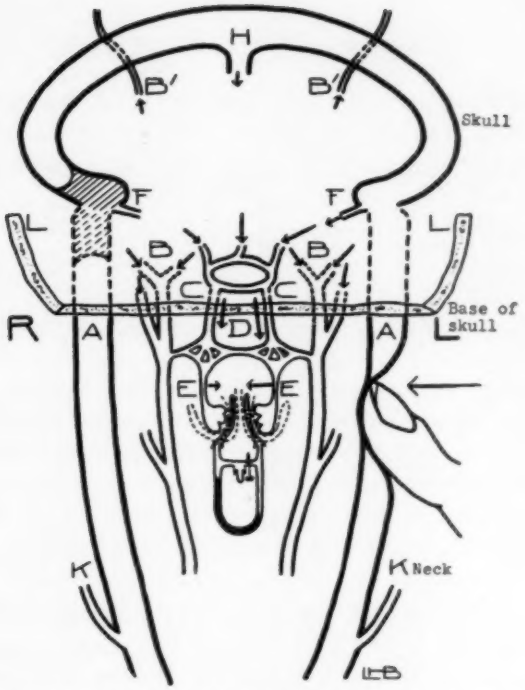

Fig. 7.—Diagram of the outflow of the blood from the skull with sinus thrombosis on the right side and pressure on the left internal jugular vein.

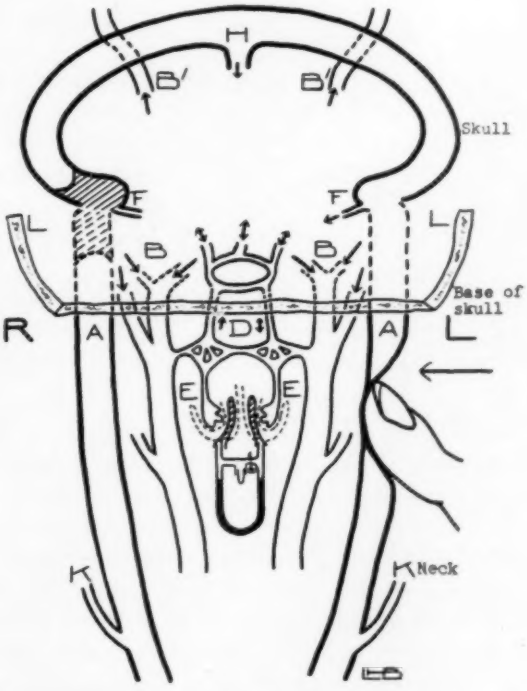

Fig. 8.—Same condition as in figure 7, but with large secondary venous connections of the skull and the neck.

side, and the symptom is negative although sinus thrombosis is present. Moreover, in such cases it is possible that pressure on the right side of the neck will compress the large deep veins. In consequence congestion in the right part of the skull may result, with swelling of the nose on the side where the thrombosis exists.

COMPARISON WITH THE QUECKENSTEDT TEST

Probably the explanation and the occurrence of this nasal phenomenon and of the Queckenstedt (Tobey-Ayer) sign may not be the same. This phenomenon is caused by the blood which is leaving the skull by the abnormal route from the cavernous sinus to the pterygomaxillary plexus, while the Queckenstedt sign is caused by the blood which cannot leave the skull in sufficient amount and thus results in increased pressure of the cerebrospinal fluid by displacement or by interference with its absorption. The results of the two tests need not be identical and may complete each other sometimes. It may be expected, for instance, that the nasal phenomenon will be positive in cases in which the Queckenstedt sign fails because of an excessive outflow of blood from the skull by means of the smaller anastomoses (*B* and *C*). The reverse will occur when in a thrombosed cavernous sinus the connection between the cranial cavity and the nose is severed. In this event, as was inferred from a patient with this disease, the nasal phenomenon is not demonstrable. In such cases there is a greater possibility of the Queckenstedt sign being strongly positive.

As an investigation comparing the results of the two tests made on a series of patients in which a lumbar puncture is indicated has not up to now been carried out, only a comparison of statistics is possible. The recent statistics drawn from Björk's extensive investigation of the Queckenstedt test in diagnosing one-sided obstruction are not encouraging. In 16 cases of operatively confirmed sinus thrombosis the test was definitely positive only three times.

The diagnostic value of nasal plethysmometry will be realized only if the test is applied on a considerable scale. Although the number of cases is not large, the results are encouraging enough to justify continuing in this direction.

SUMMARY

A new test for sinus thrombosis is described, based on the fact that compression of the healthy jugular vein, the other jugular vein being obstructed, in most cases causes congestion of the wide venous spaces of the nasal turbinates. This swelling can sometimes be detected by anterior rhinoscopic examination, but with a specially constructed *nasal plethysmometer* it can be demonstrated in every case. Some abnormal conditions in the nose and in the venous connections between the skull and the neck which may complicate the interpretation of the test are discussed.

INFECTIONS OF THE PARAPHARYNGEAL SPACE

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The pharynx is a muscular tube lined by a mucous membrane and ensheathed by the buccopharyngeal fascia. The muscular wall is derived from the superior constrictor muscle and the palatopharyngeus muscle. As Testut and Latarjet [1] pointed out, the superior constrictor muscle is but little developed at the level of the tonsils, which fact is important in order to understand the frequency of penetrating infections originating in the tonsils.

ANATOMY

At the level of the oropharynx and the nasopharynx a small space, called the parapharyngeal space or the pharyngomaxillary space, borders on the pharynx. In order to study the anatomy of this space three horizontal sections through the skull are used, as pointed out in figure 1. The first section (fig. 2) passes through the middle of the tonsils and shows the following anatomic margins of the parapharyngeal space: mesially, the wall of the pharynx; anteriorly, the internal pterygoid muscle; laterally, the parotid gland, and posteriorly, the prevertebral fascia. Posteriorly and mesially the space continues into the prevertebral space; laterally the space has a free communication with the capsule of the parotid gland, which often has dehiscences.

This space is divided into an anterior and a posterior compartment. At the level of the section shown in figure 3 this division is evidenced by a fascia having its insertion at the styloid process and extending toward the lateral wall of the pharynx. Although this fascia is not always present, the division of the parapharyngeal space is absolutely necessary from a clinical point of view, since the contents of the two compartments are completely different. Within the anterior compartment are found loose connective tissue, fat, the muscles having their insertion at the styloid process, sometimes some lymphatic glands (Hall [2]) and, finally, the lymphatic channels coming from the lateral wall of the pharynx and the tonsils and draining into the lymphatic

From the Department of Laryngology, Rhinology and Otology, University of Illinois College of Medicine.

1. Testut, L., and Latarjet, A.: Traité d'anatomie humaine, Paris, Gaston Doin, 1931, vol. 4.

2. Hall, C.: The Parapharyngeal Space: An Anatomical and Clinical Study, Ann. Otol., Rhin. & Laryng. **43**:793, 1934.

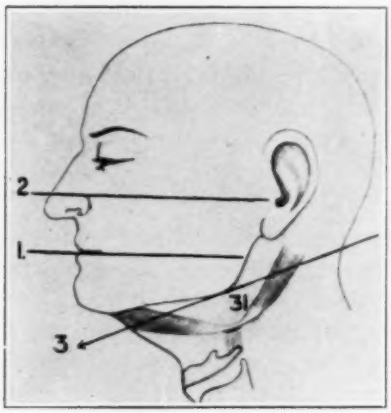

Fig. 1.—The line *1* indicates the level of the section shown in figure 2; the line *2* indicates the level of the section shown in figure 4, and the line *3* indicates the level of the section shown in figure 3. The situation of the stylomandibular ligament is indicated by *31*, which corresponds to the ligament shown in figure 3 and marked by *19*.

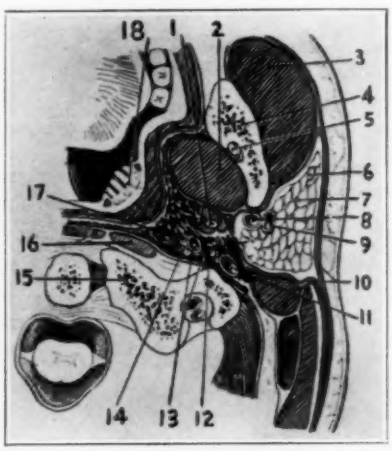

Fig. 2.—Section through the parapharyngeal space in the level indicated by *1* in figure 1. The line *1* indicates the styloid process with the stylohyoid, styloglossus and stylopharyngeus muscles; *2*, the internal pterygoid muscle; *3*, the masseter muscle; *4*, the mandibula; *5*, the inferior alveolar artery and nerve; *6*, the facial nerve; *7*, the parotid gland; *8*, the external carotid artery; *9*, the vena fascialis posterior; *10*, the parotid fascia; *11*, the vena jugularis interna and the ninth nerve; *12*, the eleventh nerve; *13*, the internal carotid artery and the tenth nerve; *14*, the superior cervical ganglion of the truncus sympathicus; *15*, the atlas with the prevertebral fascia; *16*, the longus capitis and longus colli muscles; *17*, the hypoglossal nerve, and *18*, the tonsillar palatina (Corning, H. K.: Lehrbuch der topographischen Anatomie, ed. 3, Wiesbaden, J. F. Bergmann, 1911).

glands within the parotid and the upper portion of the deep cervical glands, situated along the internal jugular vein and the inferior border of the digastric muscle. In the posterior compartment are found the internal carotid artery, the internal jugular vein and the glossopharyngeal, pneumogastric, spinal accessory, hypoglossal and sympathetic nerves.

The second section (fig. 3) passes through the inferior border of the parotid gland at the level of the mandibular angle and shows an actual division of the parapharyngeal space produced by the traversing stylopharyngeal muscle. The posterior compartment is not much changed. It contains the internal carotid artery, the internal jugular vein, the ascending pharyngeal artery, the pneumogastric, glossopharyngeal and hypoglossal nerves and, embedded in the prevertebral fascia, the sympathetic nerve.

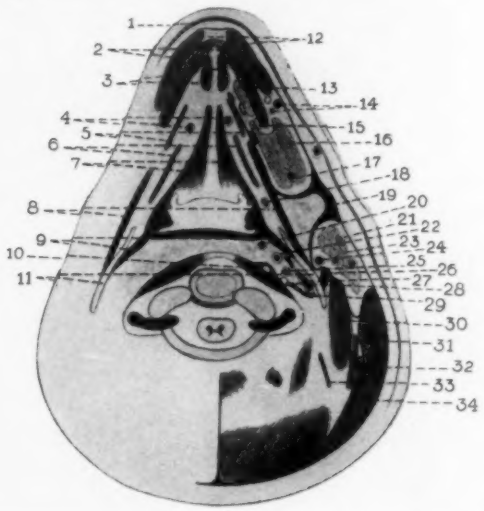

Fig. 3.—Section through the parapharyngeal space in the level indicated by *3* in figure 1. The line *1* indicates the platysma myoides muscle; *2*, the mylohyoid muscle; *3*, the geniohyoid muscle; *4*, the lingual artery; *5*, the hyoglossus muscle; *6*, the glossopharyngeal nerve; *7*, the genioglossus muscle; *8*, the styloglossus muscle; *9*, the stylopharyngeus muscle; *10*, the sympathetic nerve; *11*, the styloid process; *12*, the digastric muscle; *13*, the sublingual gland with the submaxillary duct; *14*, the submental artery and vein and the mylohyoid nerve; *15*, the lingual nerve; *16*, the submaxillary gland; *17*, the external maxillary artery; *18*, the tonsillar artery; *19*, the ligamentum stylomandibulare; *20*, the ascending pharyngeal artery; *21*, the parotid gland; *22*, the internal carotid artery; *23*, the parotid gland; *24*, the external parotid artery; *25*, the vertebral artery; *26*, the stylohyoid muscle; *27*, the vena vulgaris interna; *28*, the hypoglossal nerve; *29*, the accessorius nerve; *30*, the digastric (posterior belly) muscle; *31*, the sternocleidomastoid muscle; *32*, the longissimus capitis muscle; *33*, the occipital artery, and *34*, the splenius muscle. (After Wirtinger.)

Quite different conditions are found as far as the anterior compartment is concerned. Since the lateral margins of the space, seen in the aforementioned section (fig. 2), viz., the parotid gland and the internal pterygoid muscle, are missing at the level of the section shown in figure 3, the anterior compartment passes along the styloglossal muscle and the glossopharyngeal nerve into the narrow space between the genioglossal and the hyoglossal muscles. This space belongs to the floor of the mouth. Laterally and inferiorly, as cannot be shown in a horizontal section, the anterior compartment is limited by a thickened portion of the superficial cervical fascia, called the stylomandibular ligament. It should be kept in mind that this ligament closes the anterior compartment inferiorly; in other words, the anterior compartment is a cul-de-sac which ends inferiorly at the ligamentum stylomandibulare. This ligament lies between the inferior pole of the parotid gland and the submaxillary gland and is of importance in entering the parapharyngeal space.

The third section (fig. 4) lies above that seen in figure 2 and passes through the maxillary sinus. The posterior compartment is unchanged. It contains the internal carotid artery and the internal jugular vein. Both vessels enter the temporal bone. Between the vessels are the pneumogastric and the glossopharyngeal nerves. Finally, at this level the styloid process with its muscles is found in the posterior compartment.

Of great importance is the anterior compartment. Its margins are as follows: laterally, the ascending ramus of the mandible and the parotid gland; anteriorly and laterally, the external pterygoid muscle; anteriorly and mesially, the internal pterygoid muscle; posteriorly, the posterior compartment and the prevertebral space, and mesially, the lateral wall of the pharynx, which includes at that level the pterygoid process with its venous plexus, the levator veli palatini muscle, the tensor veli muscle and the cartilaginous eustachian tube. Anteriorly the anterior compartment passes into the spaces situated behind the maxillary sinus, viz., the pterygopalatine fossa mesially and the retromaxillary space laterally.

Also, at this level the anterior compartment largely contains loose connective tissue, lymph channels and lymph glands. In addition to this, one finds the third branch of the trigeminal nerve (the mandibular nerve) coming from the foramen ovale and dividing into the lingual, inferior alveolar and auriculotemporal nerves, also the internal maxillary artery with its branches, particularly the middle meningeal artery, running up toward the spinosal foramen, and finally the veins belonging to the pterygoid plexus.

Summarizing, one gets the following conception of the parapharyngeal space: The anterior compartment lies mesial to the mandible, in its inferior portion mesial to, and in its upper portion behind, the internal

pterygoid muscle. It extends up to the base of the skull and communicates with the dura and its sinuses along the pterygoid plexus, the third branch of the trigeminal nerve and the middle meningeal artery. Inferiorly it ends as a cul-de-sac at the stylomandibular ligament and at the upper pole of the submaxillary gland turning into the floor of the mouth at the posterior margin of the mylohyoid muscle. The anterior compartment contains in its middle portion loose connective tissue, lymph channels, lymph glands, the muscles having their insertion at the styloid process, the internal pterygoid muscle and the parotid gland; in its inferior portion, loose connective tissue, lymph channels, lymph glands and the glossopharyngeal nerve, and in its upper portion, loose connective tissue, lymph channels, lymph glands, both pterygoid muscles,

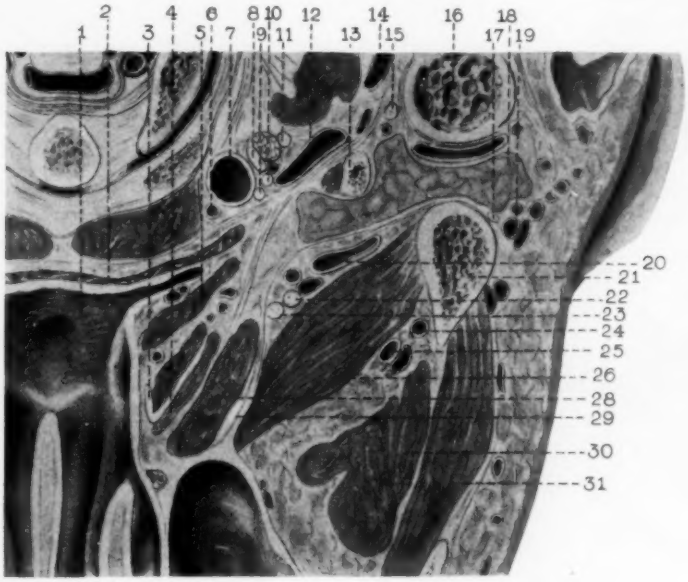

Fig. 4.—Section through the parapharyngeal space in the level indicated by *2* in figure 1. The line *1* indicates the roof of the epipharynx; *2*, the superior constrictor muscle; *3*, the pterygoid process; *4*, the tensor veli palatini muscle; *5*, the levator veli palatini muscle; *6*, the ascending pharyngeal artery; *7*, the internal carotid artery; *8*, the vagus nerve; *9*, the glossopharyngeal nerve; *10*, the accessorius nerve; *11*, the hypoglossal nerve adjacent to the ganglion superius of the sympathetic nerve; *12*, the jugularis interna; *13*, the styloid process and the stylopharyngeus muscle; *14*, the occipital artery; *15*, the facial nerve with its artery; *16*, the processus mastoideus; *17*, the auriculotemporal nerve; *18*, the parotid gland; *19*, the superficial temporal artery; *20*, the internal maxillary artery; *21*, the mandibula; *22*, the inferior alveolar nerve; *23*, the lingual nerve; *24*, the middle meningeal artery; *25*, the internal maxillary artery; *26*, the external pterygoid muscle; *28*, the internal pterygoid muscle; *29*, the pterygoid process; *30*, the fat of Bichat, and *31*, the masseter muscle. (Modified after Testut.)

the muscles of the soft palate, the veins of the pterygoid plexus, the internal maxillary artery with its branches (middle meningeal artery), the third branch of the trigeminus and the parotid gland. The posterior compartment also extends to the base of the cranium and communicates with the dura and its sinuses along the internal carotid artery, the internal jugular vein and the posterior cranial nerves. Inferiorly it extends to the upper aperture of the chest. The chief contents of this compartment are in all levels essentially the same: loose connective tissue, the internal carotid artery, the internal jugular vein, the deep cervical glands, the cranial nerves and the sympathetic nerve.

PATHOLOGY

The parapharyngeal space often becomes infected. The source of infection is usually inflammatory disease of the mucous membrane of the pharynx, particularly of the tonsils. My associates and I have observed at the Policlinic in Vienna 20 cases of infection of the parapharyngeal space.[3] In 16 instances the infection followed inflammatory disease of the mucous membrane of the pharynx; in 1 it followed a tonsillectomy; in a second, inflammatory disease at the base of the tongue; in a third, carcinoma of the tonsil, and in another a radical operation on the middle ear. The last case is of particular interest.

Case 1.—A man, 33 years old, had had a radical operation on the left side in 1929 because of cholesteatoma of the middle ear. After the operation perichondritis developed. On May 6, 1936, he complained of pain in his left ear. On May 8 his temperature rose to 100.4 F. He complained of pain on opening his mouth and of diplopia. The trismus increased. On May 12 he again had a temperature of 100.4 F. The clinical findings were deformity of the concha after perichondritis, membranous atresia of the external auditory canal, a little fetid secretion from the external canal, a little swelling in the region of the parotid gland, trismus and paresis of the left abducens nerve. On May 14 the ear was reopened. A mass of tough connective tissue was found within the cavity of the mastoid, the middle ear and the external canal. After the removal of this mass pus drained from the middle ear. A new plastic operation could not be performed, since the posterior wall of the membranous canal was absent. On May 15 and 16 the temperature was 103.3 F.; on May 17, 101.5 F. When the swelling in the region of the left parotid gland was compressed, a considerable quantity of pus escaped through the anterior wall of the external canal. With a probe, a fistula was found extending from the anterior wall of the external canal into the parapharyngeal space. On May 19 the fever decreased, but the anterior pillar of the left tonsil was definitely red. On May 22 the temperature was normal, but the patient still had diplopia, and through the fistula in the external canal pus still drained. On May 30 the diplopia disappeared and mastication was normal. On June 4 a granulomatous mass was found at the junction of the cartilaginous and the bony external canal in the anterior wall. The fistula was still draining. On August

3. Some of these cases have been published extensively by my former assistants, Dr. Waldapfel and Dr. Grabscheid, and me.

5 the temperature was again 102.2 F.; the region of the left parotid gland again was swollen. In the afternoon of the same day the pus spontaneously broke through the fistula into the external canal, and a decrease of temperature and pain followed. By August 11 the patient had recovered.

In this case the pus broke through a fistula in the anterior wall of the external canal into the parapharyngeal space. In addition to this the infection also broke into the meninges and produced paresis of the abducens nerve, probably by serous meningitis. All these unusual complications developed because of the firm connective tissue which closed the external canal.

Aside from such rare sources of infection of the parapharyngeal space interest is focused just on the infections which originate in the mucous membrane of the pharynx, particularly in the tonsils. It is well known that these infections can travel by three different routes: (1) They can pass by contiguity from the mucous membrane into the parapharyngeal space; (2) they can pass along the lymph channels, and (3) they can pass along the blood vessels.

A few years ago these different pathways were intensively discussed. Today it is known that the infection passes most often along the pathways mentioned under 1 and 2. However, the question concerning the pathways has but theoretic interest, since, as a rule, infections do not pass into the parapharyngeal space along a single way and since even microscopic examination does not always permit one to decide whether thrombophlebitis of the veins has to be considered as a cause or as a result of the suppuration within the surrounding connective tissue. Sjöberg [4] published 2 cases in which the condition was microscopically proved. Both the patients had thrombophlebitis of the veins and suppuration within the connective tissue of the parapharyngeal space. Sjöberg explained the thrombophlebitis of the veins as a result of the surrounding suppuration, and he was probably right.

It must be particularly denied that thrombophlebitis of the small veins within the peritonsillar tissue and within the parapharyngeal space often grows into the jugular vein producing thrombophlebitis. This conception is contrary to the general experience that a thrombus seldom grows from small veins into larger veins, and, indeed, it may be said that, in general, thrombophlebitis of the small veins surrounding the tonsil often occurs without producing an infection of the blood stream and furthermore that thrombophlebitis of the internal jugular vein is not common in deep infections of the neck. Summarizing the cases of

4. Sjöberg, A. A.: Contribution to the Pathogenesis of Septic Complications of Tonsils, Acta oto-laryng. **25**:68, 1937.

Waldapfel [5] and of Beck [6] and those observed by my associates and me, there are 85 cases of deep infections of the neck, in but 8 of which (about 9 per cent) has thrombophlebitis of the internal jugular vein appeared.

When the infection has penetrated into the parapharyngeal space it first affects the anterior compartment, since this part of the parapharyngeal space lies closest to the mucous membrane. On the virulence of the bacteria, on the resistance of the patient and probably on the individual variability in structure of the superior constrictor muscle and the connective tissue depend the further changes within the parapharyngeal space. However, it might be said that slight infections of the parapharyngeal space occur more often than is usually assumed, particularly after inflammatory diseases of the tonsils. Furthermore, it is possible that in instances of apparent focal infection coming from the tonsils the focal infection originates not within the tonsil but within the parapharyngeal space. Aside from the more or less chronic inflammatory diseases of the parapharyngeal space, one has to consider the changes following acute inflammations of the mucous membrane of the pharynx.

First of all lymphadenitis practically always accompanies acute tonsillitis and peritonsillitis. Under circumstances not exactly known it is possible that the infected glands which are adjacent to the internal jugular vein infect the vein before actual suppuration occurs within the parapharyngeal space or within the glands. The infection of the wall of the vein may or may not be followed by the development of a thrombus. At any rate, it is possible for sepsis to develop soon after the onset of angina and the condition is called, therefore, "fulminant sepsis after angina." Such cases have been studied particularly by Goodman [7] and Waldapfel,[8] but as early as 1912 Ruttin [9] observed a similar pathologic picture in a case in which a cervical gland infected from otitis media infected the jugular vein and thus the clinical features imitated those of sinus thrombosis.

The pathologic picture in such cases is rarely conspicuous, and I wish to emphasize that one sometimes observes cases of fulminant

5. Waldapfel, R.: Die postanginöse Pyämie, Ztschr. f. Hals-, Nasen- u. Ohrenh. **23**:178, 1929.

6. Beck, A. L.: Study of Twenty-Four Cases of Neck Infection, Tr. Am. Acad. Ophth. **37**:342, 1932.

7. Goodman, C.: Primary Jugular Thrombosis Due to Tonsil Infection, Ann. Otol., Rhin. & Laryng. **26**:527, 1917.

8. Waldapfel, R.: Ein weiterer Beitrag zur Pathogenese der postanginösen Pyämie, Ztschr. f. Hals-, Nasen- u. Ohrenh. **26**:429, 1930; Zur Klinik und Therapie der Sepsis nach Angina, Wien. klin. Wchnschr. **40**:136, 1935.

9. Ruttin, E.: Otitische lymphadenogene Septicopyämie, Beitr. z. Anat., Physiol., Path. u. Therap. d. Ohres **5**:40, 1912.

sepsis after angina in which a marked pathologic picture cannot be discovered even on autopsy. In general, however, the condition is not frequent, as Shapiro [10] pointed out in discussing the cases of Günther,[11] Dean [12] and Barnhill [13]. My associates and I observed 4 cases of fulminant sepsis after inflammatory diseases of the mucous membrane of the pharynx. In one of these cases the condition was accompanied by agranulocytosis; another was interesting because of the appearance of a heart block of short duration.

Case 2.[14]—R. G., a white man 44 years old, had previously had frequent sore throats. Two weeks before his admission to the hospital he again became ill with a sore throat, particularly on the right side. He went to bed, and after three days he felt better. On the evening of that day, however, he again felt

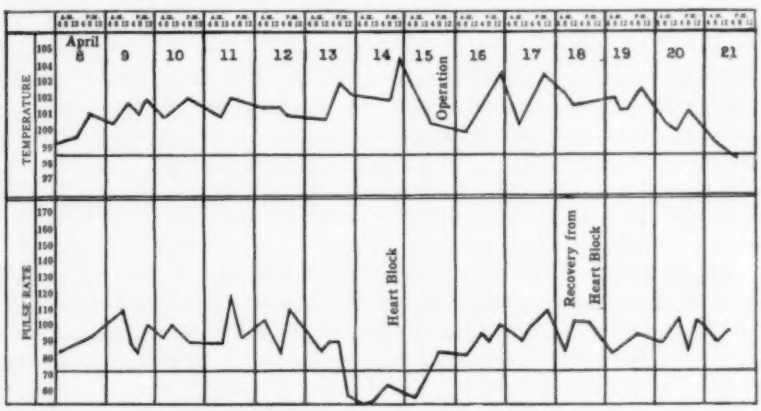

Fig. 5 (case 2).—Chart of the temperature and pulse rate.

pain in the throat; he could not swallow and had fever and a stiff neck. The pain became progressively worse, and swelling developed on the right side of the neck.

When he was admitted on April 8, 1939, he gave the impression of an ill man. Over the right side of the neck extending from the right angle of the jaw, 3 inches (7.6 cm.) of the way down along the anterior border of the

10. Shapiro, S. L.: Deep Cervical Infection Following Tonsillectomy, Arch. Otolaryng. **11**:701 (June) 1930.

11. Günther, K.: Vier Jahre Tonsillektomie an der Würzburger Universitäts Klinik, Ztschr. f. Laryng., Rhin. **17**:191, 1928.

12. Dean, L. W.: Severe Sepsis Following Tonsil Operations, Laryngoscope **20**:739, 1910.

13. Barnhill, in discussion on Glogau, O.: Abscesses Descending from the Upper Air Passages into the Neck and Mediastinum, Tr. Am. Acad. Ophth. **27**:393, 1922.

14. Case 2 was observed in the otorhinolaryngologic department of the University of Illinois. Dr. F. Lederer, head of the department, permitted me to publish it.

sternocleidomastoid muscle, there was an indurated, somewhat swollen mass, which displaced the larynx to the left. The pharynx was red and injected. Just above the right piriform sinus was a boggy whitish mass, which hung over the larynx. Breathing was not obstructed. The erythrocyte count was 4,900,000, with 85 per cent hemoglobin; the leukocyte count, 16,700, with 10 per cent lymphocytes, 3 per cent monocytes and 87 per cent neutrophils. On April 11 the leukocyte count was 14,700, with 11 per cent lymphocytes, 4 per cent monocytes and 85 per cent neutrophils. The patient received high voltage roentgen therapy and sulfanilamide and felt better. On April 14 the leukocyte count was 12,000. Both piriform sinuses were filled with pus and mucus; the cords were normal. There were no bacteria in the blood. The electrocardiogram showed left ventricular preponderance and complete auriculoventricular block with sinus arrythmia. The QRS complex was wide and markedly slurred in all leads; the ST interval in leads I, II, III and IV, elevated; the T wave, prominent in all leads, especially in leads II and IV. Nodal arrythmia, complete heart block and bundle branch block of the common type, probably on the basis of vagal pressure, were noted (fig. 5).

On April 15 an operation was performed. An incision was made along the anterior border of the sternocleidomastoid muscle. The internal jugular vein was exposed from the level of the cricoid cartilage to the digastric muscle. A large inflamed lymph node was found lying over the internal jugular vein and the common facial vein. It was removed. The wall of the anterior facial vein was whitish, in contrast with the blue walls of other veins. The vein was resected. A thrombus was not found within it. The anterior compartment of the right pharyngomaxillary space was opened, but pus was not found. The microscopic examination of the lymph node revealed chronic inflammation; the examination of the vein, thickening of the wall due to chronic inflammation. On April 16 the patient felt fairly well but complained of difficulty in swallowing. The electrocardiogram showed the S-T interval in leads I and II less elevated, the PR element prolonged, T_1 low, T_2 isoelectric and T_3 inverted. The heart block had then become merely a first degree heart block; otherwise the electrocardiogram was normal, indicating a release of vagal pressure. On April 18 septic arthritis of the left knee developed. The knee was aspirated, and 25 cc. of opalescent, thick, somewhat cloudy but sterile fluid was removed. The electrocardiogram showed tachycardia. The P wave in leads I and III was high and sharp, P_4 inverted and T_4 low and diphasic. The normal electrocardiogram indicated the complete release of vagal pressure. From then on recovery was uneventful.

The case is typical. The sepsis set in three or four days after the beginning of his angina and was characterized by a general downward course, moderate leukocytosis, fever and metastasis. The pathologic picture found at operation was not conspicuous—a large lymph node adjacent to the vein, chronic inflammation of the wall of the vein and edema of the surrounding tissue, in other words, a finding typical of fulminant sepsis. In spite of this inconspicuous pathologic picture rapid recovery followed the operation.

The heart block, found at the climax of the sepsis, was explained by vagal pressure. According to the findings during operation one

rather has to consider septic inflammation of the vagal nerve causing the heart block.

In contrast to fulminant sepsis is slowly progressive suppuration of the connective tissue, the lymph channels and the lymph glands within the parapharyngeal space, the "abscesses of the parapharyngeal space," particularly studied by Waldapfel.[15] The suppuration is so slowly progressive that the abscess may reach an enormous size and be surrounded by a thick capsule, which is, as a rule, densely infiltrated by polymorphonuclear leukocytes and consists of connective tissue, part of which has undergone hyaline degeneration, and of muscle tissue. My associates and I observed 12 abscesses of the parapharyngeal space.

When the infection has a higher degree of virulence "phlegmon of the parapharyngeal space" develops instead of an abscess, as first described in 1920 by Mosher.[16] My associates and I observed 5 [17] such cases. In cases of this type purulent necrosis of connective tissue often takes place, with development of but little pus. The great danger of the phlegmon is that it may spread within the connective tissue spaces and affect the veins, particularly the internal jugular vein, with subsequent sepsis, as pointed out by Mosher.

The propagation of the phlegmon chiefly takes place in the following directions:

(*a*) The phlegmon penetrates from the anterior compartment into the posterior compartment of the parapharyngeal space and spreads downward along the sheath of the blood vessels, resulting in thrombosis of the jugular vein, mediastinitis, edema of the larynx, pleuritis and metastases.

(*b*) The phlegmon penetrates from the anterior compartment into the posterior compartment and spreads upward along the sheath of the blood vessels, resulting in one or all of the following conditions: erosion of the internal carotid artery, phlebitis of the cavernous sinus, meningitis and abscess of the brain.

(*c*) The phlegmon spreads from the anterior compartment along the styloglossal muscle, resulting in phlegmon of the floor of the mouth and possibly, though rarely, osteomyelitis of the mandible.

It must be admitted that the infection spreads, as a rule, from the anterior compartment in more than one direction. Nevertheless, it is advisable from a clinical point of view to keep the foregoing division

15. Waldapfel, R.: Parapharyngeale Lymphdrüsenabscesse nach Angina, Pract. oto-rhino-laryng. **2**:69, 1939.

16. Mosher, H. P.: Deep Cervical Abscess and Thrombosis of the Internal Jugular Vein, Laryngoscope **30**:365, 1920.

17. The sum of the cases observed by my associates and me is 21 and not 20 because 1 case is mentioned twice since the patient once had an abscess of the parapharyngeal space and at another time fulminant sepsis.

in mind, particularly the differentiation between fulminant sepsis, abscess and phlegmon. The following case, in which an abscess and fulminant sepsis originated in the pharynx, shows the importance of the described division.

Case 3.—K. P., a man 55 years old, suffered from polyarthritis for one year. On May 30, 1933, he suddenly became ill, with a high temperature and chills. At the same time the rheumatic pain disappeared. On June 3 there was a swelling at the angle of the right side of the jaw as large as a pigeon's egg. The swelling was firm, slightly tender and movable. Speech was indistinct, but there was no hoarseness. The temperature was normal. The right vallecula and the right half of the epiglottis were covered by necrotic tissue. The right pharyngoepiglottic fold, the right half of the epiglottis and the right aryepiglottic fold were swollen. The Wassermann reaction of the blood was negative. The leukocyte count was 7,500, with 45 per cent neutrophils, 4 per cent juvenile forms, 27 per cent lymphocytes, 8 per cent monocytes, 6 per cent metamyelocytes and 10 per cent myelocytes. The sputum did not contain Koch's bacilli. The temperature on the evening of June 9 was 99.5 F. The necrotic tissue disappeared. There was a deep ulcer with smooth walls and sharp margins between the tongue and the pharyngoepiglottic fold on the right side. The temperature on June 12 was 98.2 F.; on June 17, 98.7 F. The ulcer at the base of tongue was smaller. The swelling at the angle of the jaw increased and was firm, indolent and but little movable. On June 21 a specimen was taken for biopsy from the margins of the ulcer, which showed edema and chronic inflammation. No polymorphonuclear cells could be found in the section, but some lymphatic follicles were present. The temperature on June 23 was normal. The swelling at the angle of the jaw increased. On June 24 incision of the swelling revealed a large abscess with a thick capsule consisting of hyaline connective tissue, muscle tissue and many polymorphonuclear cells. An uneventful recovery occurred. On November 9, 1933, the patient suddenly became ill again, with fever and general malaise. On November 10 he was drowsy and vomited three times. At noon he was unconscious. During the night of the tenth the temperature was 105.6 F. and the pulse rate 88. Meningeal symptoms could not be found; the ears were normal. Both palatoglossal arches were red, the right more than the left. In the superior part of the right palatoglossal arch circumscribed edema and hemorrhage were seen. The lateral wall of the pharynx on the right side and the entire lingual surface of the epiglottis were red, as in erysipelas of the pharynx. The epipharynx was normal, as were the lungs, spleen, eyegrounds and cerebrospinal fluid. The scar on the right side of the neck was red and little swollen. On November 11, the temperature was 104.2 F.; the pulse rate, 110. The leukocyte count was 2,000. A smear revealed only small and old lymphocytes. On November 12 the patient died.

At autopsy edema of the base of the tongue, of the mucous membrane of the pharynx and of the aryepiglottic folds, swelling of the lymph glands on the right side of the neck and acute tonsillitis were noted. The jugular vein was normal. Microscopically I observed many necrotic areas in the mucous membrane of the base of the tongue and in that of the pharynx. In the region of the vallecula there were many subepithelial blood vessels filled with plugs of streptococci. The surrounding tissue, however, was but little changed. The tonsils were atrophic, and their lymphatic tissue was normal; the adjacent muscles of the pharynx also were normal. Some plugs of streptococci were found within the capillaries in the peritonsillar tissue.

The patient primarily had a large abscess in the parapharyngeal space following an inflammatory disease of unknown origin in the base of the tongue. The abscess developed with but few general symptoms, as such abscesses always do. However, the blood count was surprising even at that time. Usually one finds in such cases either a normal blood count or slight leukocytosis. In this case there was slight leukopenia, with a great amount of immature marrow cells (6 per cent metamyelocytes and 10 per cent myelocytes) and without eosinophils. Although I did not know the blood count of the patient under normal circumstances, it must be said that the quoted blood count signalized a disturbance either in the development of the polymorphonuclear cells within the marrow or in the effusion of the polymorphonuclear cells from the marrow into the blood stream. This finding makes it, however, more clearly understood why four months after the first recovery the patient again became ill with acute pharyngitis combined with typical granulocytopenia.

SYMPTOMATOLOGY

The symptoms of the inflammatory diseases of the parapharyngeal space are dependent (1) on the localization and (2) on the nature of the inflammation. In general one can differentiate between two kinds of symptoms: (*a*) general symptoms and (*b*) local symptoms. The local symptoms, which are more marked the more slowly the inflammation progresses within the parapharyngeal space (Wessely),[18] can be divided into (1) organic symptoms and (2) mechanical symptoms.

Looking on the three different kinds of inflammatory disease within the parapharyngeal space, one finds these clinical entities: In instances of fulminant sepsis the general symptoms are in the foreground, viz., septic fever and chills and later enlargement of the spleen and jaundice. Of great importance in such cases are the findings in the blood. First, the absolute number of leukocytes is important. Various findings will be noted. There are cases in which marked leukocytosis occurs (according to Shapiro[10] up to 20,000), but there are also cases in which the condition is combined with leukopenia and even with granulocytopenia, like case 3 of the present series. Waldapfel[19] pointed out that the conditions combined with leukopenia have, as a rule, a bad prognosis. Furthermore the eosinophils are of importance, since the prognosis improves when these cells appear within the blood stream, a good sign in all cases of sepsis, as is well known.

Beside these general symptoms, the local symptoms are of less importance. It is true that slight swelling of the glands is seen at the

18. Wessely, E.: Die endokraniellen Komplikationen nach Tonsillitis und Peritonsillitis, Eine klinische Studie, Monatschr. f. Ohrenh. **66**:1190, 1932.

19. Waldapfel, R.: Ueber Leukopenie bei pharyngogener Sepsis, Monatschr. f. Ohrenh. **69**:1178, 1935.

angle of the jaw and along the jugular vein, but similar findings will be obtained with ordinary peritonsillitis. However, a complication must be suspected when the jugular vein is tender along its entire course or can be felt as a firm cord. But such findings are seldom obtained in cases of this type.

It is true even now that poverty of local symptoms explains the frequent errors in the diagnosis of such cases. Usually the condition is mistaken for pneumonia, typhoid fever or acute arthritis. Therefore, it must be kept in mind that in every case of angina an inflammatory disease of the parapharyngeal space is to be suspected, particularly of the jugular vein when the fever has not disappeared within three or four days or when chills are observed during that time. That is particularly true when fever or chills are observed and the inflammation of the tonsils has more or less disappeared. Mosher [16] emphasized this point.

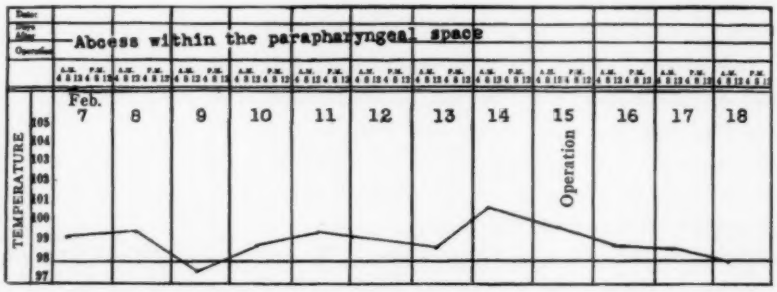

Fig. 6.—Abscess within the parapharyngeal space; temperature chart.

I wish to mention the following case as typical:

CASE 4.—F. K., a man 40 years old, on June 2, 1934, became ill with a follicular angina. On June 6, the angina was subsiding, but a chill was observed. On June 7 the temperature was 103.8 F. Again a chill was observed. In the upper part of the jugular vein a swollen gland was palpable. The tonsils were removed. On June 8 the temperature was again 103.8 F. The leukocyte count was 19,100, with 65 per cent polymorphonuclear cells, 4 per cent juvenile forms, 23 per cent lymphocytes, 7 per cent monocytes and 1 per cent myelocytes. The vessel sheath was opened, and an inflamed gland was found adjacent to the internal jugular vein. There was no pus within the parapharyngeal space. An uneventful recovery occurred.

General symptoms are of less importance with abscesses of the parapharyngeal space than with fulminant sepsis. Chills are rarely present, and the temperature rises but little, to about 100.4 F. (fig. 6). Accordingly, signs of general sepsis seldom appear in such cases. Only with more progressive conditions are there higher temperatures, moderate leukocytosis (often without shifting to the left) and some-

times signs of disease of the kidneys. The general symptoms, of course, increase rapidly when the abscess perforates its capsule and spreads into the connective tissue of the parapharyngeal space.

However, in such cases the local symptoms, primarily the mechanical symptoms, are marked. Most striking is the swelling at the angle of the jaw. Here is found a firm, little movable, indolent swelling covered with normal skin. This swelling grows relatively fast and may reach the size of a fist. Since such abscesses, as mentioned earlier in this paper, are covered with a thick capsule, fluctuation as a rule is missed, as Mosher,[20] Hall [2] and Waldapfel [15] have pointed out. The swelling rather gives the impression of a glandular tumor. Against this diagnosis, however, is the relatively rapid growth of the swelling in a not very ill patient. Sometimes these abscesses feign the aspect of woody phlegmon. It is understood that such swellings may produce a reduction of the movements of the head.

The abscesses do not grow only from within outward; they also grow inward and may extend upward along the vertebral column. As a result of that direction of growth, the tonsils and the lateral wall of the pharynx may bulge inward (prolapse of the tonsils and palatal arch, Beck [6]), and the palatopharyngeal arch and the aryepiglottic folds may become edematous, so that marked difficulties in swallowing are noted. Finally a moderate degree of trismus is produced in such cases, as Shapiro [10] pointed out, by inflammation of the internal pterygoid muscle and the pterygomandibular ligament (Uffenorde [21]).

Wessely [18] referred to the fact that the trismus sometimes may disappear without change in the other local symptoms and without spontaneous rupture of the abscess. This finding ought to signify the penetration of a peritonsillar abscess into the parapharyngeal space. My associates and I could observe the same finding in 1 of our cases, but we do not agree with Wessely's explanation of this finding. As our case taught us, the disappearance of the trismus without improvement of the general and local symptoms does not always signalize perforation of the superior constrictor muscle of the pharynx, but sometimes large destruction of the internal pterygoid muscle.

When the abscess develops in the upper portion of the anterior compartment or when it extends into that area, organic symptoms are added to the mechanical symptoms just mentioned. These organic symptoms originate particularly in the trigeminal nerve. The patients

20. Mosher, H. P.: The Submaxillary Fossa Approach to Deep Pus in the Neck, Tr. Am. Acad. Ophth. **34**:19, 1929.

21. Uffenorde, W.: Die vom Schlunde ausgehenden septischen Allgemeinerkrankungen mit makroskopischen und mikroskopischen Demonstrationen, in Premier Congrès international d'oto-rhino-laryngologie, Copenhagen, Th. Linds Efterfolger, 1928, p. 3.

complain of pain in the teeth and of headache, which radiates to the temporal area, to the ear or to the occiput. I call particular attention to the last mentioned symptom, because some writers explain the headache as a manifestation of basilar meningitis. According to the experience of my associates and me, this explanation is not quite right. We ascribe it to a disease of the auriculotemporal nerve, which leaves the third branch of the trigeminus just below the foramen ovale.

In order to demonstrate the symptoms of such abscesses I describe the following case, which was long observed and which shows what happens when such a condition is not recognized for a long period.

Case 5.—Mr. P., 49 years old, on Jan. 19, 1933, became ill with a sore throat and a chill. He did not take his temperature. On January 23 he was better. On January 25 he again had a sore throat and a chill. Again the temperature was not taken. A few days later an incision was made within the throat, after which improvement was noticed. But a few days later he again noticed pain in swallowing and an increasing swelling at the angle of the right jaw. On February 7 he had a septic appearance. However, the temperature was 99.1 F. There was a marked swelling at the angle of the right jaw and slight trismus. The right tonsil was pushed forward toward the middle line, the palatopharyngeal arch, the lateral wall of the pharynx and the right aryepiglottic fold were swollen. An incision of the lateral wall of the pharynx did not reveal any pus. On February 8 the temperature was 99. The displacement of the tonsil, the edema within the pharynx and the swelling at the jaw increased, but not the trismus. On February 9 the temperature was 96.8 F.; the leukocyte count, 14,900, with 87 per cent polymorphonuclear cells, 8 per cent lymphocytes and 5 per cent monocytes. In the urine albumin and casts were found. On February 11 the temperature was 99.3 F.; the erythrocyte count, 4,200,000; the Sahli reaction, 78 (87 per cent); the color index, 1.04, and the leukocyte count, 17,000, with 83 per cent polymorphonuclear cells, 1 per cent juvenile forms, 10 per cent lymphocytes and 6 per cent monocytes. Incision of the right palatoglossal arch revealed but little pus. On February 13 the temperature was 98.7 F. The swelling within the pharynx and at the jaw increased. There was some shortness of breath. On February 14 the temperature rose to 100.4 F. There was typical woody phlegmon on the right side of the neck but no fluctuation and no trismus. On February 15 the temperature was 99.7 F. The patient appeared septic. The leukocyte count was 13,500, with 80 per cent polymorphonuclear cells, 11.5 per cent lymphocytes and 8.5 per cent monocytes. Therefore, a prophylactic mediastinotomy was performed, and a large abscess within the right parapharyngeal space was drained. The abscess extended into the prevertebral space. In the pus streptococci were found. Uneventful recovery ensued.

When such abscesses reach a certain size they may perforate spontaneously. Beck [6] described a case in which the abscess perforated into the external auditory canal. In 1 of the cases observed by my associates and me a similar, but not identical, condition was met. We observed another case in which the abscess perforated through the tonsil into the mouth. In this case, indeed, the patient had carcinoma of the tonsil with secondary infection of the parapharyngeal space.

CASE 6.—R. P., a man 50 years old, had had syphilis twenty years before. In March 1937 he noticed pain in swallowing and a swelling at the angle of the left jaw. Catarrh of the pharynx was diagnosed and treated. The swelling at the jaw, however, remained. In April 1937 angina developed, with a temperature of 100.4 F. After one week he recovered. On Aug. 13, 1937, he again noticed pain on swallowing and suddenly the swelling at the angle of the left jaw increased to the size of an apple. Moreover, he noticed pain radiating into the left ear, but no fever was observed. Since the Wassermann test was positive, his syphilis was treated with 1 cc. of a suspension of bismuth salicylate in olive oil (bismogenol) twice and 0.45 cc. of neoarsphenamine three times. During the following days, the swelling at the jaw increased, and marked trismus developed. On August 26 he suddenly expectorated much blood and pus, and the swelling decreased. On September 13 a slightly tender, immovable gland was found at the angle of the left jaw; furthermore, a large ulcer on the left palatoglossal arch and another large purulent ulcer on the left tonsil were discovered. A biopsy of a specimen from the ulcer on the tonsil revealed chronically inflamed (gummatous?) tissue but no signs of malignancy. He was treated with iodine. On September 22 the conditions were markedly improved. The ulcer on the tonsil was clean, the glands diminished and the trismus improved. He again received antisyphilitic treatment. On Jan. 1, 1938, the swelling at the jaw was again markedly increased, and he again noticed pain on swallowing. A few days later he again expectorated blood and pus, and on January 10 the pain on swallowing and the swelling at the jaw disappeared. On January 3 a large ulcer on the left tonsil was found. The ulcer destroyed the entire palatoglossal arch, extending forward to the ascending branch of the mandible and upward into the soft palate. The ulcer had perforated through the superior constrictor muscle. Glands were not found at the angle of the jaw. A second biopsy revealed nonhornifying squamous cell carcinoma. He was given a Coutard treatment with roentgen rays. After a short period of improvement, he died in May 1938 of cachexia.

Such spontaneous perforations of abscesses within the parapharyngeal space are not frequent. Certainly the laryngologist should not rely on them, as it is more common for the abscesses to perforate into the prevertebral space or into the posterior compartment than into the mouth or through the skin.

As far as the clinical aspect is concerned, phlegmon lies between fulminant sepsis and abscess within the parapharyngeal space. When it develops typically it is characterized by general symptoms as well as by local symptoms. As far as the general symptoms are concerned, high temperature and chills occur (fig. 7). Nevertheless there are exceptions in that sometimes phlegmon of the parapharyngeal space may set in with a critical downfall of temperature signalizing a collapse of the circulatory system. Orton [22] described such cases, and my associates and I also have seen such cases. Accordingly, as in cases of sepsis from other origins, the sepsis with collapse temperature has a bad prognosis.

22. Orton, H. B.: Deep Infections of the Neck, Ann. Otol., Rhin. & Laryng. **47**:48, 1938.

As far as the findings in the blood are concerned, I have to repeat what I said regarding fulminant sepsis. My associates and I did not observe, however, a case of phlegmon with granulocytopenia. Other general symptoms are yellow discoloration of the sclera, disease of the kidneys, swelling of the spleen, septic edema of the larynx, edema of the brain and, finally, metastases.

At the beginning of the disease the local symptoms are of course not so marked as in the instance of an abscess. Nevertheless, swelling at the angle of the jaw, trismus and sometimes swelling in the region of the parotid gland may be found early. The local symptoms, however, increase, as a rule, when the phlegmon spreads into the surrounding tissue, which can occur, as was mentioned, in three directions:

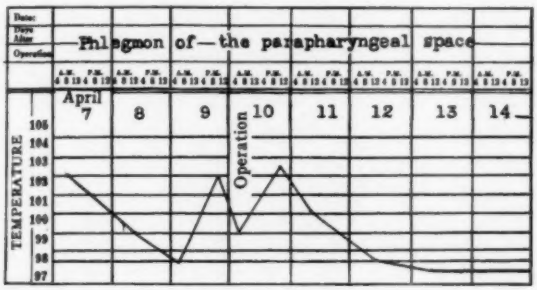

Fig. 7.—Phlegmon of the parapharyngeal space; temperature chart.

(1) along the vessel sheath, downward, (2) along the pterygoid plexus and the third branch of the trigeminus nerve, upward, and (3) along the styloglossal muscle, forward.

In the first event one finds tenderness along the jugular vein, tenderness above the clavicle and sometimes a swelling of glands along the jugular vein. Many years ago Poulson [23] emphasized that in such cases the pus seldom penetrates into the mediastinum, which corresponds with what my associates and I observed. Waldapfel,[5] however, found among 44 cases 13 instances (29 per cent) of mediastinitis. Pearse [24] found that gravitation of pus from the neck causes only one fifth of the cases of suppurative mediastinitis; in this group, however, are found many of the more dangerous infections from esophageal perforations.

23. Poulson, K.: Ueber Abscesse am Halse, Deutsche Ztschr. f. Chir. **37**:55, 1893.

24. Pearse, H. E.: Mediastinitis Following Cervical Suppuration, Ann. Surg. **108**:588, 1938.

In the second event there are typical pain in the teeth, headache and a feeling of obstruction of the ears, due to acute serous catarrh of the middle ear. Wessely [18] in 3 of his cases observed typical neuralgia of the trigeminus nerve. I wish to repeat that from the headache per se one should not conclude that basilar meningitis exists. I [25] have previously described a case which belongs in this group.

In the third case phlegmon of the floor of the mouth developed with swelling of the skin, as well as swelling of the mucous membrane at the floor of the mouth. I [26] observed a case of this kind.

Case 7.—B. F., 45 years old, with a history of frequent sore throat, became ill on April 19, 1936, with fever and difficulty in swallowing. On April 20 the difficulty increased, and the temperature rose to 104 F. No chill was observed. The diagnosis of acute pharyngitis and follicular angina was made. There were no swollen glands at the angle of the jaw. In the evening the patient had a temperature of 102.2 F. but no chill. On April 21 the temperature decreased. On April 22 the temperature again rose to 102.2 F. No chill was observed, but there was some shortness of breath. A thorough examination revealed a septic color of the face, euphoria, cyanosis and a swelling at the angle of the left jaw as large as a fist. The swelling extended into the submental region, and at the angle of the right jaw there were some enlarged glands but not as marked as on the left side. Fluctuation could not be found. The left vessel sheath was tender. There was tenderness above the clavicles. The tip of the tongue was elevated toward the hard palate. The floor of the mouth below the tip of the tongue was swollen and red. There were plugs of pus at the opening of the left submaxillary duct. Both palatoglossal arches were swollen but not markedly red. The mucous membrane of the hypopharynx was edematous. The epiglottis was edematous and showed on its laryngeal surface a small ulcer. The vocal cords could not be seen. The left palatoglossal arch was incised. Pus was not found. On April 23 the temperature rose to 102.7 F. without a chill. An external operation was planned. After the incision of the skin the patient suddenly died.

The observations at autopsy were typical of sepsis. The microscopic examination of the floor of the mouth revealed phlegmon with the production of but little pus and much necrosis. The phlegmon originated within the left parapharyngeal space after follicular angina, traveled, in the form of a horseshoe with the convexity toward the spina mentalis, through the floor of the mouth and broke spontaneously into the mouth in the region of the right vallecula. The phlegmon passed the midline within the transverse space between the geniohyoid and genioglossal muscles.

It would, of course, be wrong to believe that phlegmon always spreads in one of the three directions mentioned. On the contrary, one must suppose that it usually spreads in more than one direction.

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25. Brunner, H.: Brain and Meningeal Symptoms of Pharyngeal Origin, Ann. Otol., Rhin. & Laryng. **48**:259, 1939.

26. Brunner, H.: Ueber einen Fall von Mundbodenphlegmone nach Angina follicularis, Monatschr. f. Ohrenh. **10**:1436, 1936.

However, one direction is always the chief direction. This fact will be demonstrated by the following case:

CASE 8.—D. S., 56 years old, became ill on April 6, 1937, with fever and sore throat. On April 7 spontaneous rupture of a peritonsillar abscess on the right side was noticed. After the rupture the patient had two chills. On April 8 the temperature decreased. The abscess drained well, but she again noticed one chill. On April 9 the temperature was 97.5 F. in the morning and 102.2 F. in the evening, when she again had two chills. On April 10 I saw her for the first time. She did not look septic. Her temperature was 99.3 F. There were swelling at the angle of the right side of the jaw, slight tenderness of the right jugular vein, headache, pain in the teeth on the right side and moderate trismus. The right tonsil was draining well from the upper lacuna. The leukocyte count was 8,350, with 75 per cent polymorphonuclears, 5 per cent juvenile forms, 4 per cent monocytes, 15 per cent lymphocytes and 1 per cent eosinophils. In the evening the temperature rose to 102.6 F. Therefore, the vessel sheath was exposed, and the parapharyngeal space was opened. No pus but a serohemorrhagic fluid was found within the space. Then the tonsil was removed, and a big peritonsillar abscess was drained. After the tonsillectomy a fistula was found in the inferior part of the tonsillar niche leading into the parapharyngeal space. An uneventful recovery occurred.

In this case the tenderness of the jugular vein indicated that the suppuration within the parapharyngeal space had a tendency to spread downward along the vein, while the pain in the teeth and the headache pointed to an ascending infection. Further, it should be noted that leukocytosis was not found and that even the eosinophils had not disappeared. The patient, therefore, was operated on in an early stage.

When patients with phlegmon are operated on one often finds but little pus. However there is marked hyperemia and a serohemorrhagic exudate within the tissue. When the condition has progressed, purulent necrosis of the tissue is most often found (gangrenous phlegmon)—but not much frank pus.

The symptomatology of inflammation of the parapharyngeal space given in this paper naturally is somewhat schematic, since the margins between the three kinds of inflammation I have spoken of are not as sharp as one would believe from reading this description. Nevertheless, the different kinds of inflammation within the parapharyngeal space each represent a different clinical entity, at least in the majority of instances.

PROGNOSIS

The prognosis is dependent (1) on the constitutional resistance of the patient, (2) on the character of the inflammation and (3) on the time when the operation is performed. Of the 4 patients with fulminant sepsis seen by my associates and me, 2 died and 2 were cured by an external operation. Of our 12 patients with abscess within the

parapharyngeal space 2 died and 10 recovered. Included with the 2 patients who died is the patient with the carcinoma of the tonsil (case 6) and the one in the following unusual case:

CASE 9.—I. H., 34 years old, had a history of frequent sore throats for many years. In 1931 his tonsils were removed. On Sept. 18, 1933, pain developed on the left side of the throat. Simultaneously he had pain on the left side of the occiput and in the teeth of the left side and trismus. Ten days after the onset of the disease a swelling on the left side of the neck appeared. The swelling was incised by a general surgeon and a little thin pus evacuated, but the temperature did not decrease. The parapharyngeal space was not opened. A few days later tender swelling at the lateral wall of the pharynx behind the niche of the left tonsil was discovered. On September 30 the parapharyngeal space was opened from the palatoglossal arch by a general surgeon. A considerable amount of pus was evacuated, and it was found that the wound within the mouth communicated with the wound in the neck. The parapharyngeal space was irrigated daily through the mouth, and a critical fall in temperature occurred. However, the patient complained of intense headache. On October 7 the temperature rose to 106 F. New incisions were made within the mouth, and the parapharyngeal space was again irrigated. The temperature slowly decreased, but the headache, particularly the pain in the temples and in the right forehead, persisted. The pain in the teeth did not abate; so a bridge between the upper teeth on the left side was removed. On January 2 some scars were found in the left palatoglossal arch. The niche of the right tonsil was empty; in the niche of the left tonsil there was a small piece of tonsillar tissue. The pharynx and larynx were otherwise normal. The diagnosis of an abscess within the right frontal lobe was made. The abscess was opened and drained on January 3. On January 18 the patient died. The autopsy revealed severe purulent pachymeningitis interna over the right cerebral hemisphere but no leptomeningitis. Suppuration was not found within the parapharyngeal space or the paranasal sinuses.

An abscess within the left parapharyngeal space followed peritonsillar phlegmon. It was clinically characterized by pain in the occiput, pain in the teeth and trismus. It was opened from the neck, but the parapharyngeal space was not entered. Therefore, the temperature did not decrease, and the lateral wall of the pharynx on the left side was pushed into the pharynx. Twelve days after the onset of the disease the parapharyngeal space was opened from the mouth only. This operation gave the patient a few days' relief, but the pain in the head and in the teeth persisted and signalized ascending infection of the parapharyngeal space. The general surgeon who operated on the patient did not realize the danger and instead of opening the parapharyngeal space radically irrigated it through the mouth. This treatment was more dangerous than helpful. (Wessely[18] after injecting india ink into the parapharyngeal space under low pressure found the ink at the base of the skull, in the vicinity of the foramen ovale.) Indeed, the patient seven days after the opening of the parapharyngeal space had a high temperature again, and his pain persisted and grew even worse. New incisions were made, and the parapharyngeal space was

again irrigated through the mouth. The temperature now slowly decreased, but the pain did not, and gradually neurologic symptoms developed, indicating an abscess within the right frontal lobe.

There is no doubt that the condition was a metastatic abscess of the brain originating from the inflammation within and beyond the pharyngeal wall. The fatality was, at least partially, due to the treatment. It is, of course, impossible to say that the patient could have been saved by other treatment, but one can say that the treatment administered was not the proper one.

Of the 12 patients with abscess within the parapharyngeal space seen by my associates and me, 9 had an external operation. One of these died. One patient's abscess was drained as late as one month after the disease. Despite that fact the patient recovered. For 1 patient the abscess was drained through the mouth. This abscess developed after tonsillectomy. The patient recovered. Two patients experienced spontaneous rupture of the abscess, 1 case into the external auditory canal and the other through the tonsil into the mouth. Of those 2 patients 1 died (of carcinoma of the tonsil).

Of the 5 patients with phlegmon of the parapharyngeal space 4 died. The 4 who died included 1 who died without operation, 1 who died immediately after the incision of the skin, 1 for whom the operation was undoubtedly too late, because my associates and I failed to make a diagnosis in time, and, finally, 1 in whom the sepsis, originating from the phlegmon, developed with such rapidity that even early operation could not save him.

My associates and I lost 8 of 20 patients (40 per cent). This mortality is high, since Orton [22] lost only 3 of 16 patients (19 per cent) and Beck [6] only 1 of 24 patients (4.2 per cent). The mortality in our series is surpassed, however, by that which Waldapfel [5] reported, for he lost 25 of 43 patients (58 per cent). The great difference can be explained when one considers that the number of fatalities rapidly increases when one has to deal with cases of fulminant sepsis or phlegmon and that the cases of Waldapfel [5] were observed at a time (1905) when but little was known of deep infections of the neck. From our experience I reach the conclusion that of all inflammatory diseases of the parapharyngeal space the abscesses have by far the best prognosis.

TREATMENT

The inflammatory diseases of the parapharyngeal space must be treated surgically. I admit that abscesses of the parapharyngeal space may heal by spontaneous rupture. However one never knows if that will happen. Therefore, even with abscesses operation is indicated.

The first question which arises is whether an endoral or an external operation should be performed. In cases of fulminant sepsis and of typical phlegmon there can be little doubt. In such cases only the external approach can be considered. However, one meets another situation when abscesses are concerned. In such cases the surgeon's decision is dependant on the intensity of general symptoms and the size of the abscess. One cannot expect an abscess which is accompanied by marked general symptoms or which produces enormous swelling on the outside of the neck to heal after an endoral operation alone. In such cases the external operation has to be performed. In abscesses, however, which have not progressed far, an endoral approach is surely justified. The endoral operation should be performed in such a manner that the superior constrictor muscle is perforated. It will, as a rule, be necessary to remove the tonsil, since one has to consider the tonsil as a tampon which hinders the adequate evacuation of pus from the parapharyngeal space into the mouth.

As far as the external approach is concerned, Waldapfel [5] made it clear that the surgeon primarily should drain the abscess within the parapharyngeal space, the operation on the blood vessels being of secondary importance. In connection with the external operation the question of anesthesia has to be considered. This is a difficult problem when one has to deal with severe sepsis. Local anesthesia with procaine hydrochloride in such cases is dangerous, as Waldapfel pointed out. I saw a patient who died immediately after the local anesthetic was injected (case 7). Likewise rectal anesthesia induced by avertin with amylene hydrate is dangerous for patients who suffer from inflammatory disease of the upper respiratory tract. Finally, in 2 cases reported by Wassmund [27] respiration stopped immediately after the slow intravenous injection of 3 to 4 cc. of evipansodium. In 1 of these cases a large abscess within the submaxillary space, and in the other an abscess within the parapharyngeal space, was observed. General anesthesia with ether is apparently the best method, provided that the mucous membrane of the upper respiratory tract is not inflamed. A few years ago I advised bolstering the circulation of the blood with heart stimulants and with blood transfusions before operation in cases of severe sepsis. Naturally this advice cannot be followed when the operation has to be performed in an emergency.

The incision of the skin can be made either along the horizontal branch of the mandible or along the anterior border of the sternocleidomastoid muscle. My associates and I prefer the latter incision for two reasons. First, this incision avoids the marginal branch of the

27. Wassmund, M.: Lehrbuch der praktischen Chirurgie des Mundes und der Kiefer, Leipzig, 1935.

facial nerve, which runs along the inferior border of the mandible, and, second, the incision can easily be prolonged if the surgical findings demand thorough exposure of the vessel sheath. In cases in which an abscess develops within the inferior part of the parapharyngeal space elevation of the sternocleidomastoid muscle, as a rule, is sufficient to drain the abscess and the parapharyngeal space. However, one meets another situation in cases of phlegmon and in cases of abscess which develops within the superior part of the parapharyngeal space. In these cases the parapharyngeal space has to be drained from the stylomandibular ligament. This operation is simple if the anatomic conditions are not obscured by swelling of the lymphatics and edema of the connective tissue. The stylomandibular ligament, situated between the parotid glands and the submaxillary gland, must be perforated by a dilator, which is forcefully introduced into the parapharyngeal space in the direction to the tip of the nose.

If the anatomic situation is not easily recognized it is advisable to incise the superficial fascia of the neck and to expose the posterior belly of the digastric muscle. The muscle is followed to its tendon, which can easily be located where it perforates the stylohyoid muscle. Above the muscles the parapharyngeal space can be entered. One can simplify the operation by retracting the submaxillary gland forward in the direction of the submental spine, which will remove the external maxillary artery from the surgical field. However, it is rarely necessary to elevate the submaxillary gland with its capsule as Mosher [26] recommends, as the submaxillary gland is but seldom involved. Oral surgeons maintain that not more than 2 or 3 per cent of the acute inflammations within the submaxillary and sublingual compartments are due to the tonsils (Wassmund [27]). The sheath of the blood vessels must be extensively exposed in all cases in which symptoms of sepsis occur. It should not be incised, but inspected. If there are adjacent lymphatic glands, they must be removed. If, after removal of the glands, the sheath is apparently normal further exposure should not be made. If there are pathologic changes in the sheath it must be opened. Further operative procedure is dependent on the changes in the wall of the internal jugular vein. Since it is known that thrombosis of the jugular vein is, as a rule, induced by periphlebitis, one is confronted by a situation similiar to that met on exposure of the sigmoid sinus, as Mosher [20] has emphasized. In a case of simple periphlebitis combined with fever but without chills, intermittent fever or septic symptoms, the periphlebitic focus must be thoroughly exposed without incision of the vein. If, in the course of the disease, intermittent fever, chills or septic symptoms are observed, the vein must be ligated below the diseased area, or the entire periphlebitic focus must be

removed. As in disease of the sigmoid sinus, it may happen that the wall of the vein heals with development of white scars but the endophlebitis and the thrombus remain. In such a case the clinical symptoms as well as the white (instead of blue) color of the wall of the vein can lead one to the correct diagnosis.

My associates and I have performed prophylactic mediastinotomy, but we no longer do so, for the pus seldom gravitates to the mediastinum; the patients succumb much earlier to the sepsis. When the inflamed focus is under control, gravitation of pus practically never occurs. If, during the operation, it is discovered that the phlegmon extends down to the mediastinum or near it, one should enter it, following the phlegmon. In such rare cases, however, one does not deal with "*prophylactic*" mediastinotomy.

There is not, at this time, much surgical aid for the patients in whom a phlegmon of the parapharyngeal space extends into the base of the skull.

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OSTEOMYELITIS OF THE FRONTAL BONE

SURGICAL TREATMENT: WHICH WAY OF APPROACH IS THE BEST?

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Osteomyelitis of the frontal bone may be extraordinarily dangerous, because of the rapidity with which it spreads and the frequency with which it is followed by intracranial complications. The treatment—immediate and radical surgical intervention—should therefore be instituted automatically when the diagnosis has been made.

In most cases it originates from acute or chronic sinusitis, and the operation has, therefore, two purposes: (1) to remove all the diseased part of the bone and to drain possible deep-seated inflammation (leptomeningitis, epidural abscess or possibly abscess of the brain) and (2) to clean out and drain the sinuses from which the infection has originated.

The bone affected by osteomyelitis behaves as though it contained a malign tumor. The resection must therefore be performed in healthy tissue. It may be difficult, and is sometimes impossible, even *during* the operation to decide with certainty where the bone is healthy. *Before* the operation it is impossible to do so. A procedure must, therefore, be chosen which fulfils the conditions mentioned and at the same time gives a good cosmetic result. This is possible by the employment of the following technic:

TECHNIC

A coronal incision is made from one ear to the other above the hair line, beginning a little in front of the upper point of attachment of the external ear. The incision is made right through the scalp, including the periosteum. There is little bleeding, as no branches of arteries of any size are to be found here, the few which bleed being ligated. The scalp covering the frontal bone is now easily reflected forward over the face by means of a napkin. In this way all the frontal bone and the adjacent parts of the parietal bone are laid bare, and a full view down to the supraorbital margins is obtained. Unrestricted access is now available for resection of the frontal bone, the frontal sinuses, the ethmoid labyrinth and, if necessary, the roof of the orbit and the lamina cribrosa. The scalp is then drawn back and fixed in its central third by means of mattress sutures or napkin clips. Large meches, soaked in dilute solution of sodium hypochlorite (Carrel-Dakin solution), and a couple of rubber drains split longitudinally are introduced under the scalp from the angles of the wound. Contraincisions are generally made in the "shadow" of the eyebrows, though this can sometimes be avoided, as the drainage to the angles of the wound is excellent and a broad outlet to the nose has been established after resection of the ethmoid labyrinth. When the dressing is changed the whole cavity is washed out from the angles of the wound.

As the secretion gradually decreases, the drainage is reduced, and the scalp, of which only the central third was fixed immediately after the operation, is now brought more nearly into place. If napkin clips have been used, they are merely moved a little farther down on the side of the head. When the wound has healed the cicatrix is concealed by the hair. The bone gradually regenerates entirely, even after extensive resection, and the forehead becomes smooth. The cosmetic and mimetic results are shown by some of the illustrations.

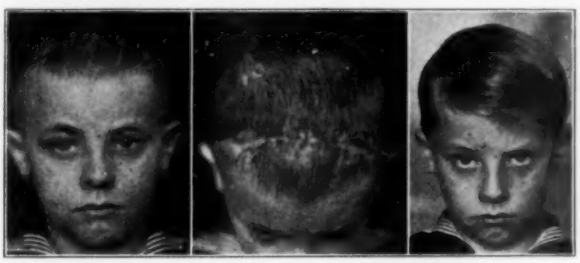

Fig. 1.—Acute bilateral frontal sinusitis and osteomyelitis of the frontal bone. Most of the frontal bone on the left, most of the orbital roof and a little less of the corresponding osseous parts on the right were removed.

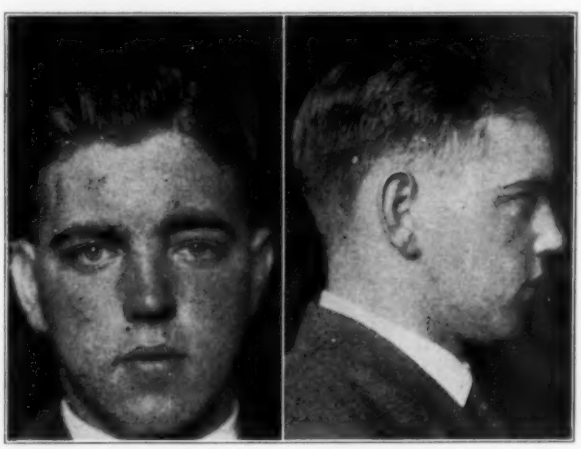

Fig. 2.—Acute frontal sinusitis on the left and osteitis of the frontal bone. The large frontal sinus and the adjacent part of the frontal bone were resected. The photographs show the final result.

The method was elaborated by Mygind and was first published by his assistant Hvidberg,[1] in 1932, later results being published by Mygind [2] himself.

1. Hvidberg, H.: Nouvelle technique opératoire pour les grandes ostéites frontales, Compt. rend. Soc. franç. d'oto-rhino-laryng. **45**:50-57, 1932.

2. Mygind, S. H.: Heruntesklappen des Skalps bei Ostitis frontalis, Acta oto-laryng. **26**:537, 1937.

Fig. 3.—Acute frontal sinusitis on the right, osteomyelitis of the frontal bone and epidural abscess. A piece of the frontal bone 8 by 7 cm. was resected. Examination five years later showed that the whole defect was replaced by a hard but somewhat wrinkled bone.

Fig. 4.—Acute bilateral pansinusitis. The whole of the anterior wall in the large frontal sinuses was resected.

Fig. 5.—Fracture through the squama frontalis, extending downward into the orbit and through both the frontal sinuses and the ethmoid labyrinths. Sequestrectomy, resection of the lamina cribrosa and incision of the dura were performed.

He has used the method in 13 cases of osteomyelitis of the frontal bone. Eleven patients were cured, and 2 died, but the 2 were extremely ill on admission to the hospital, 1 having hemiparesis, which indicated intracranial complications, and the other leptomeningitis. The latter died during the operation.

The frontal sinus of only 1 of the patients had been operated on before the occurrence of osteomyelitis; none of the other patients had been operated on at all, which contradicts the opinion predominant in some quarters that in most cases osteomyelitis of the frontal bone occurs after, and as a result of, surgical intervention on the frontal sinus.

Adson and Hempstead,[3] of the Mayo Clinic, independently of Mygind, reported in 1937 an absolutely identical procedure and they, too, were able to show excellent results. They, too, emphasized the fact that small stab wounds are quite ineffective, as they allow only limited drainage and do not permit the removal of necrotic bone. Abscess of the brain may result.

Skillern [4] made a large horizontal incision through the upper edge of the eyebrows toward the sides of the cranium and in this way was able to draw upward the scalp covering the forehead. The exposure of the frontal bone was, of course, excellent, but, judging from the accompanying photograph, the cosmetic and mimetic result was hardly as good as when Mygind's method is employed.

The method also afforded excellent assistance in a case of traumatic streptococcic meningitis with fracture through the squama frontalis extending downward into the orbita and through both the frontal sinuses and the ethmoid labyrinths, from which sequestrums were removed. The lamina cribrosa was also resected, and the dura was split, a muddy liquid appearing. Finally a section of the frontal bone 8 by 13 cm. was removed in this way in resecting a large osteoma ossis frontalis.

SUMMARY

Unrestricted access for resection of the frontal and the adjacent parts of the parietal bone, the frontal sinuses, the ethmoid labyrinth, the roof of the orbit and the lamina cribrosa is obtained by a coronal incision above the hair line, which permits reflection of the scalp covering the forehead forward over the face. The cicatrix is concealed by the hair, and, as no branches of the facial nerve and no muscles have been cut and as no tense scars are to be found on the forehead, the cosmetic and mimetic results are ideal.

3. Adson, A. W., and Hempstead, B. E.: Osteomyelitis of Frontal Bone Resulting from Extension of Suppuration of Frontal Sinus: Surgical Treatment, Arch. Otolaryng. **25**:363 (April) 1937.

4. Skillern, S. R.: Osteomyelitic Invasion of the Frontal Bone Following Frontal Sinus Disease, Ann. Otol., Rhin. & Laryng. **48**:392, 1939.

THE PIRIFORM SINUS

ANATOMIC AND CLINICAL OBSERVATIONS, WITH A REVIEW OF THE LITERATURE

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The piriform sinus, also termed recessus, or fossa, pyrifomis, is occasionally described as being part of the larynx, but, since it lies outside of that organ, is, strictly speaking, part of the hypopharynx. It appears as a deep depression between the cricoid and arytenoid cartilages and the posterior surface of the thyroid cartilage on each side of the larynx. It is situated beneath the pharyngoepiglottic fold. Its mucous membrane laterally adjoins the posterior surface of the ala of the thyroid cartilage. In its anterior part is a low fold, the plica nervi laryngei superioris, which is produced by the internal branch of the superior laryngeal nerve and which runs downward and medially (fig. 1). The piriform sinus is limited above by the hyoid bone and below by the lower border of the cricoid cartilage. In many persons, especially those who are not too obese, one can see a white line running obliquely through the piriform sinus. This line marks the upper border of the thyroid cartilage (fig. 1).

One cannot see all these details on examining every larynx with the mirror but often only what is shown in figure 2. Phonation aids in bringing out further details. The plica nervi laryngei is rarely perceptible in the living subject. However, as Zuckerkandl has already pointed out, the nerve running through this fold can occasionally be seen shining through the mucosa in cachectic persons. I have, however, seen the nerve in its entire course through the piriform sinus in a number of perfectly normal patients (fig. 1). In other patients one sees only a part of the nerve (fig. 3). The superficial course of this nerve, as I shall point out later, is of interest in several respects.

Anomalies of the piriform sinus are relatively rare. One of the more common ones, if it can be called an anomaly, is the projection of the upper cornu of the thyroid cartilage into the piriform sinus. In such cases one sees a rounded prominence, which is hard to the touch (fig. 4). It does not cause any symptoms. On a few occasions I have seen folds in the piriform sinus which might be attributable to retarded development (fig. 5). Sometimes a fractured hyoid bone projects into

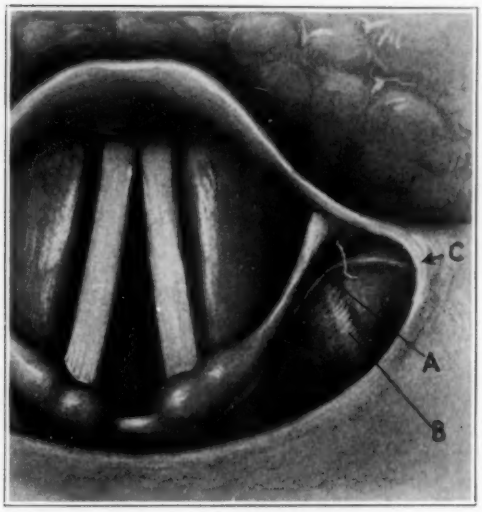

Fig. 1.—Left piriform sinus. *A* indicates the superior laryngeal nerve; *B*, the white line marking the upper border of the thyroid cartilage, and *C*, the pharyngoepiglottic fold.

Fig. 2.—Left piriform sinus, showing no details.

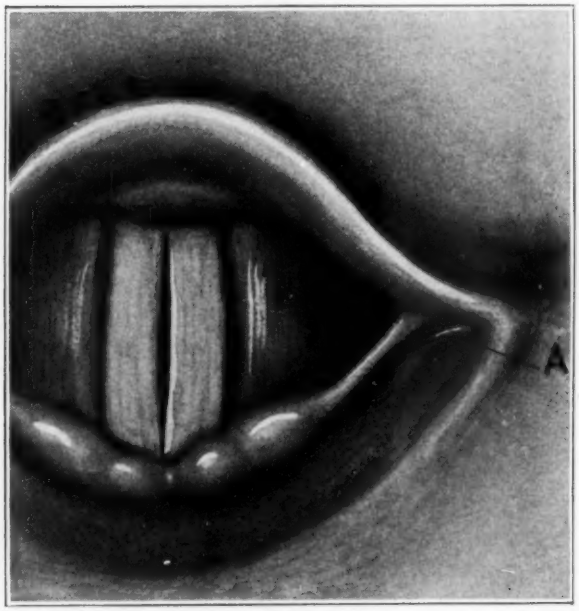

Fig. 3.—Left piriform sinus with only a part of the superior laryngeal nerve visible (*A*).

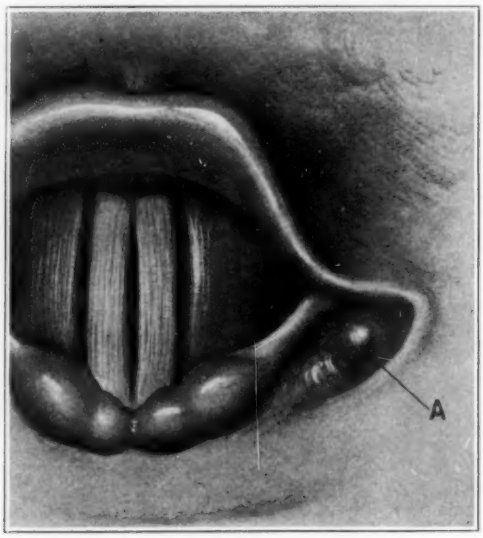

Fig. 4.—Projection of the upper cornu (*A*) of the thyroid cartilage into the piriform sinus.

the lumen of the hypopharynx and is seen a little above the piriform sinus. Similarly, fractures of the large cornu of the thyroid cartilage can be seen in the piriform sinus if the cornu is bent inward.

The course of the sensory laryngeal nerve through the piriform sinus is so superficial that it is possible to produce anesthesia of the nerve by applying a local anesthetic directly to the mucosa of the piriform sinus, provided that it is applied for a sufficient length of time. This procedure is used by some laryngologists before operations on the larynx.

In some cases of painful deglutition due to tuberculosis in which Hoffmann's method [1] of blocking the nerve by means of an alcohol

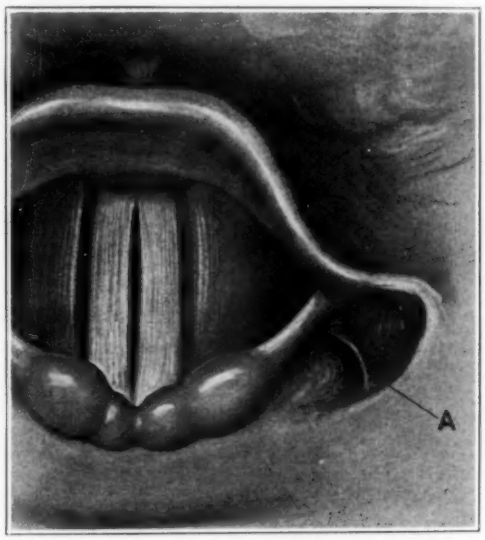

Fig. 5.—*A*, a fold in the left piriform sinus.

injection from the outside was unsuccessful I have succeeded in striking the nerve through the piriform sinus.[2]

The nerve runs below the pharyngoepiglottic fold in its course through the piriform sinus (figs. 1 and 3). The site of injection should therefore be in this area. As already mentioned, the nerve can be seen as clearly as shown in figure 1 in only the occasional larynx. It is not, however, necessary to see the nerve in order to block it by injection. A knowledge of its position in the piriform sinus is sufficient, and the

1. Hoffmann, R.: Daueranaesthesie im tuberkulosen Kehlkopf, München. med. Wchnschr. **22**:739-740, 1908.

2. Schugt, H. P.: Superior Laryngeal Nerve Block Anaesthesia Via the Pyriform Sinus in Tuberculosis of the Larynx, Am. J. Surg. **7**:659-661, 1929.

injection need be made only superficially. I have used the Alexander syringe with a curved cannula and a fine point. Not more than 0.5 cc. of alcohol should be injected. The patient generally experiences a pain in the ear which is similar to the typical pain felt when Hoffmann's method of injecting from the outside is used. The danger of necrosis of the mucosa developing may be argued as a point against the method, but I have not as yet observed such a complication. This method should not and cannot supplant that of Hoffmann but may be used in cases in which his and other methods have failed.

The Hoffmann method is used for operative purposes when the sensory nerve is to be blocked through infiltration with procaine hydrochloride or a similar local anesthetic. I have been able to produce as satisfactory anesthesia in a series of cases by injecting procaine hydrochloride around the nerve in the piriform sinus. The approach from the outside is, however, less disturbing to the patient and easier for the physician.

The mucosa of the piriform sinus is made up of the same stratified squamous epithelium as is found in the rest of the pharynx and also contains a number of mucous glands which are subject to variation. While in one case it may be difficult to find even one mucous gland, in another there may be several. They are most often found in the greatest number on the outer surface of the arytenoid cartilages. They are rarely found on the inner surface of the thyroid cartilage (Dobrowolski [3]). The mucous glands of the piriform sinus rarely show cystic degeneration, a condition which is more often seen on the arytenoid cartilages and on the aryepiglottic fold. Congenital cysts the lining of which can be seen in the piriform sinus and which are really subepithelial cysts, as they do not arise from the mucous membrane of the piriform sinus although covered by this membrane, are rare. Their removal is best accomplished from the outside according to Klose [4]: A transverse incision between the hyoid bone and the thyroid cartilage is made from the outside. The upper border of the thyroid cartilage is then exposed, and the thyrohyoid membrane is cut. The upper border of the thyroid cartilage is freed by blunt dissection, and the cyst is removed without entering the lumen of the larynx.

It is obvious that the piriform sinus is subjected to constant irritation by food sliding past during deglutition. Whether or not this irritation plays a part in the relative frequency of carcinoma in the sinus has never

3. Dobrowolski, Z.: Lymphatic Follicles of the Mucous Membrane of the Esophagus, Stomach, Larynx, Trachea and Vagina in Man and Animals, Pam. Towarze. Lek. Warszaw **88**:458 and 801, 1892.

4. Klose, W.: Zwei Fälle von seltneren Kehlkopftumoren, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **145**:154-158, 1938.

been proved. The act of swallowing in its relation to the piriform sinus can be studied roentgenologically with the use of barium. The latter flows to the esophageal orifice on both sides of the epiglottis. The divided stream flows along the sides of both piriform sinuses and can be seen to unite once more into one shadow at the orifice of the esophagus (von Pannewitz [5]).

Acute inflammations localized in the piriform sinus are rare. In such cases the patients complain of rather severe pain on the affected side. On examination the rest of the pharynx, of the nasopharynx and even of the larynx appears normal.

I have been unable to find much in the literature about the diseases of the piriform sinus. Dobrowolski [3] is the only who has gone into much detail about its histologic structure. He has shown that in addition to the mucous glands previously mentioned there is lymphatic tissue the structure of which closely resembles that of the palatine tonsil. He has therefore called it the tonsil of the piriform sinus. Of 60 cases he found this "tonsil" in 8. It can be found in cadavers as well as in the living subject, and it appears as a mass of tissue projecting beyond the mucous membrane. It varies in size from that of the head of a pin to that of a pea. But the greater part of this lymphatic tissue lies buried in the depths of the mucous membrane, so that it actually can be the size of a small bean. Figure 6 shows an unusually large mass of lymphoid tissue in the piriform sinus, seen in an otherwise normal patient. The "tonsil" is situated deeply in the recessus piriformis, near its anterior recess, and is sometimes barely visible.

Wiethe [6] and, among others, Schumacher [7] have confirmed Dobrowolski's findings.[3]

The lymphatic tissue contains a large number of follicles with germinating centers, as well as a large centrally located crypt. It is covered on its upper surface with pharyngeal mucous membrane, namely, stratified squamous epithelium. This epithelium also lines the crypt. The "tonsil" shows well developed interstitial connective tissue as well as a rather firm capsule. Wiethe has described pathologic changes in this lymphatic tissue of the piriform sinus. The histologic sections showed typical angina just as is found in the examination of the palatine tonsil. As a result of his examinations, Wiethe was able to prove that inflam-

5. von Pannewitz, G.: Partielle Schlucklähmung als Roentgensymptom, Fortschr. a. d. Geb. d. Röntgenstrahlen **44**:170-177, 1931.

6. Wiethe, C.: Ueber die Tonsilla sinus piriformis: Ein Beitrag zur Aetiologie des akuten Larynxödems, Ztschr. f. Hals-, Nasen- u. Ohrenh. **30**:235-239, 1931.

7. Schumacher, S., in Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohren-Heilkunde, Berlin, Julius Springer, 1925, vol. 1.

matory reactions with peritonsillar edema can occur in the tonsil of the piriform sinus. It is easily understandable that this can lead to more severe complications. Edemas of the arytenoid cartilage or of the aryepiglottic fold are often seen, which in some cases cannot be attributed to primary inflammations of the tissues in the neighborhood or to an injury from a foreign body. One can understand in view of the foregoing observations that these edemas may develop from diseased lymphatic tissue in the piriform sinus.

Wiethe demonstrated with histologic sections that the cellular infiltration which occurs in the capsule of this lymphatic tissue and in the vicinity thereof is similar to that in the palatine tonsil, and that, in his

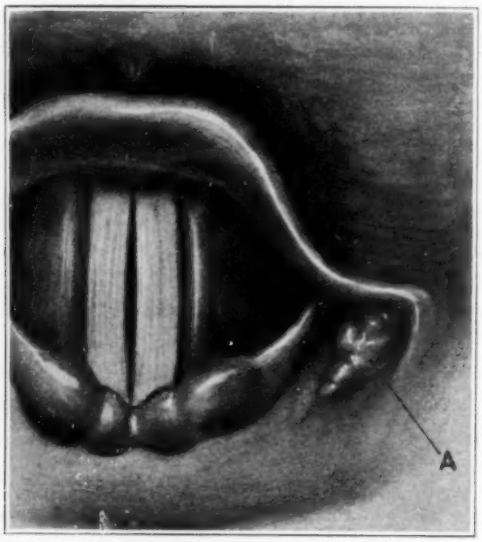

Fig. 6.—An unusually large mass of lymphoid tissue in the left piriform sinus (personal observation).

opinion, can occasionally cause a phlegmonous process of the larynx. I have often wondered how certain isolated abscesses within the larynx arise, especially those that are found on the inner side of the ala of the thyroid cartilage and extend into the piriform sinus. With the majority of these abscesses, one knows from the history and physical findings that primary tonsillitis or pharyngitis is the probable cause. For others there is a traumatic basis (Kernan and Schugt[8]). Occasionally, there is no evidence of any disease in the vicinity of the larynx. Since the piriform sinus forms a part of the posterior surface of the thyroid

8. Kernan, J. D., and Schugt, H. P.: Abscess of the Larynx and Its Treatment, Ann. Otol., Rhin. & Laryng. **43**:1009, 1934.

cartilage, it is possible for an abscess to form in the larynx from an isolated infection of the lymph tissue in the sinus if the inflammation has penetrated the interior of the larynx by way of the loose submucous tissue. In addition, the piriform sinus is the most dependent part of the hypopharynx and acts in a way as a receptacle for inflammations which may spread from the higher-lying organs, such as the pharynx and the tonsils. Such inflammations can easily lead to edematous conditions in the piriform sinus. This can be better understood from a study of the distribution of the lymphatics. The lymphatic structure of the piriform sinus will be described in greater detail in the course of this article.

The piriform sinus plays an important part in the diagnosis of abscess of the thyroid cartilage, but unfortunately little attention has

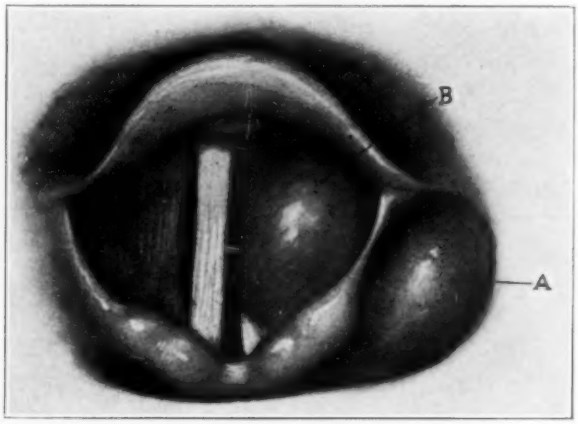

Fig. 7.—Abscess of the larynx pointing into the piriform sinus (*A*) and ventricular band (*B*).

been given in the medical literature to its importance. Pieniazek [9] was the first to mention the role of the piriform sinus in laryngeal abscesses. With infections of the thyroid lamina, the floor of the piriform sinus bulges upward (fig. 7), because the upper and posterior portions of the thyroid cartilage form an unyielding wall externally (fig. 8). Incisions of such abscesses through the piriform sinus are not always completely curative. The abscess cavity refills with pus, and after a few days a fluctuating mass can again be found in the piriform sinus. In the paper previously mentioned,[8] Kernan and I described a method of approaching such abscesses from the outside through an opening in the thyroid cartilage (fig. 9). This permits better drainage. In 1 case I incised the

9. Pieniazek, P.: Die Verengerungen der Luftwege, Vienna, Franz Deuticke, 1901, p. 140.

Fig. 8.—Section through the larynx to show the extension of an abscess, as seen in figure 7. *A* indicates the abscess pushing into the lumen of the larynx and *B* the abscess bulging into the piriform fossa. At *C* the arrows show the site of the window made through the cartilage in order to approach the abscess.

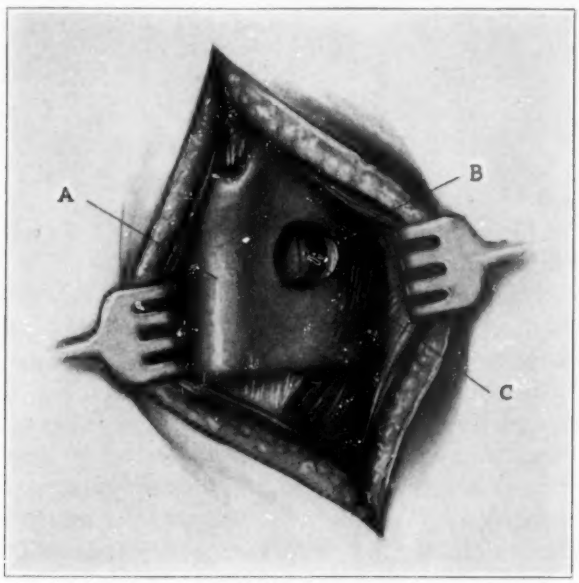

Fig. 9.—External approach to the abscess in the larynx and piriform fossa through (*A*) exposure of the thyroid cartilage and (*B*) a window in the thyroid cartilage. *C* indicates the inner perichondrium, incised. The abscess was found to be between the mucosa and the perichondrium.

abscess through the piriform sinus several times before deciding to approach it externally through an opening in the thyroid cartilage. There were no ill effects from the repeated internal incisions. However, 1 of the cases illustrates that the incising of a laryngeal abscess from above, as is recommended in the textbooks, should be done with caution, especially if there is great swelling and distortion of the parts. The patient had considerable swelling in the region of the aryepiglottic fold and near the piriform sinus. He was in great distress and had difficulty in breathing. The larynx was exposed with a direct laryngoscope, and an incision was made into the most prominent part of the swelling. Pus was released, but there was also a profuse hemorrhage, which might

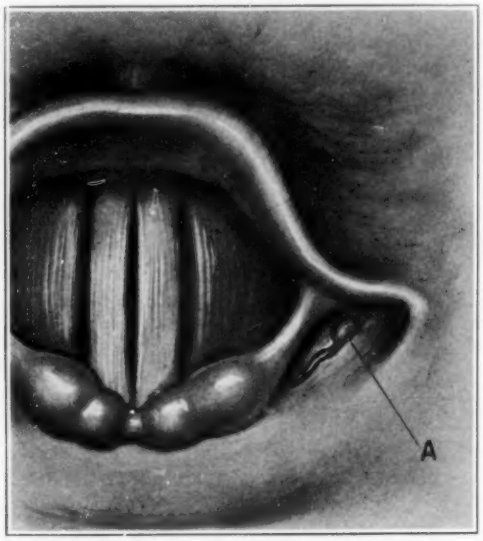

Fig. 10.—Left piriform sinus with dilatation of the superior laryngeal vein (*A*).

have been fatal and which subsequently required exposure and ligation of the carotid artery. Figure 10 shows the piriform sinus with a dilated vein, the superior laryngeal vein. It is not hard to understand that a hemorrhage from this vessel or from the nearby artery can occur when a laryngeal abscess is incised.

The anatomy of this region explains why inflammations in the piriform sinus do not always remain localized. Posteriorly and laterally the piriform sinus is in contact with the posterior surface of the pharynx. This in turn is bound to the prevertebral fascia by loose, movable connective tissue, rich in lymphatics. Thus there is a direct path for inflammation to spread to the mediastinum. At this point the various ways should be described in which abscesses of the posterior surface of the

thyroid cartilage, particularly those of the piriform sinus, can invade the neighboring tissues of the neck and the mediastinum:

1. Pus can spread from the piriform sinus along the posterior surface of the thyroid cartilage and, breaking through the cricothyroid ligament, reach laterally into the deep tissues of the neck. From here the pus can then follow the great vessels into the mediastinum. Kernan and I have described a case.[8] The remarkable thing about this case was that the abscess crossed over between the trachea and the esophagus to the opposite side and in this way reached the mediastinum on that side (fig. 11).

2. Another path exists from the piriform sinus around the posterior edges of the thyroid cartilage into the region of the great vessels (fig. 12). We described such a case, in which the abscess was drained externally through an incision.[8] The pus was found on the outer covering of the inferior constrictor muscle of the pharynx. Laryngeal examination in this case revealed a large mass involving the right aryepiglottic fold and piriform fossa. This mass was displaced toward the left side by a swelling of the right lateral pharyngeal wall. The appearance of the larynx, together with the presence of an external swelling, was evidence that the pus had made its way from the piriform fossa to the outside of the larynx and from there to the sheaths of the great vessels.

3. The abscess in the piriform sinus can break through the thyroid cartilage anteriorly without being definitely palpable or visible. This is due to its deep position behind the sternohyoid and sternothyroid muscles. In such cases the abscess may burrow downward and be imperceptible until later, after it has descended into the mediastinum. It may then appear as a painful swelling in the second intercostal space next to the sternum. O. Mayer, of Vienna,[10] described such a case. I, myself, have never seen this rare complication. In most instances, when the abscess has broken through the thyroid cartilage anteriorly, it can fortunately be palpated on the outer surface of this cartilage and thus be readily diagnosed. Figure 13 shows the swelling in such a case, and figure 14 shows the findings after exposure of the thyroid cartilage. In this case necrosis of the upper part of the cartilage was present. A probe could be passed from there into the piriform sinus and could be seen there on examination with the mirror.

4. The fourth path has already been mentioned and leads from the piriform sinus into the neighboring spatium praevertebrale, from which

10. Mayer, O.: Beiträge zur Behandlung der Perichondritis laryngea auf Grund eigener klinischer und histologischer Untersuchungen, Ztschr. f. Hals-, Nasen- u. Ohrenh. **28**:309-379, 1931.

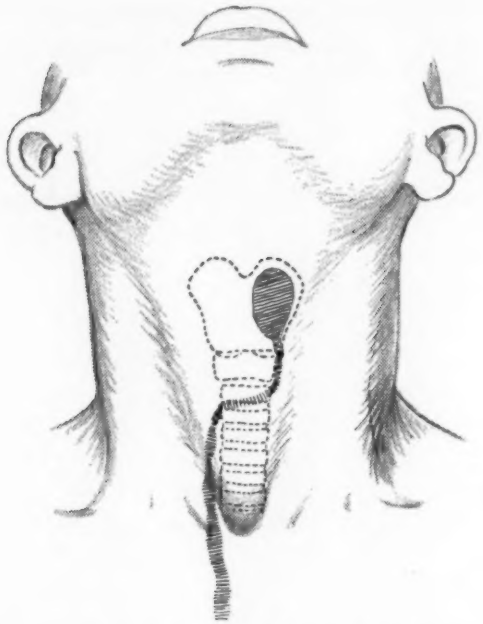

Fig. 11.—An abscess in the larynx behind the left thyroid plate and in the piriform fossa has broken through the cricothyroid membrane and burrowed downward behind the trachea into the right side of the mediastinum.

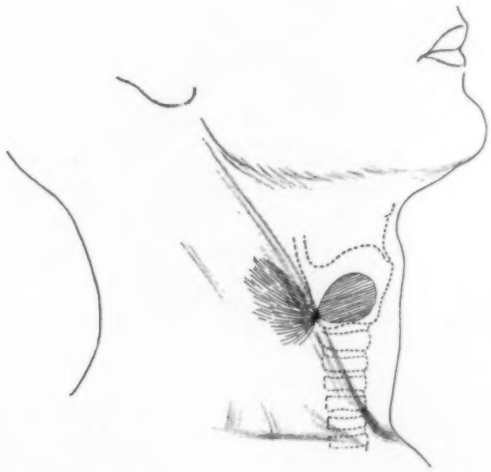

Fig. 12.—An abscess of the larynx after breaking through the piriform sinus into the paralaryngeal space, pushing the sternocleidomastoid muscle laterally.

a direct path leads to the posterior mediastinum. Roberts [11] asserted that in cases in which an abscess of the piriform sinus ruptures downward into the posterior mediastinum, the mediastinum can be opened and

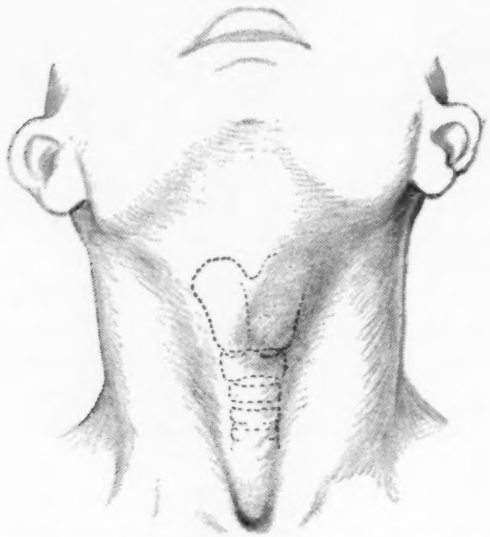

Fig. 13.—External swelling, after the abscess has broken through the thyroid cartilage to the outside.

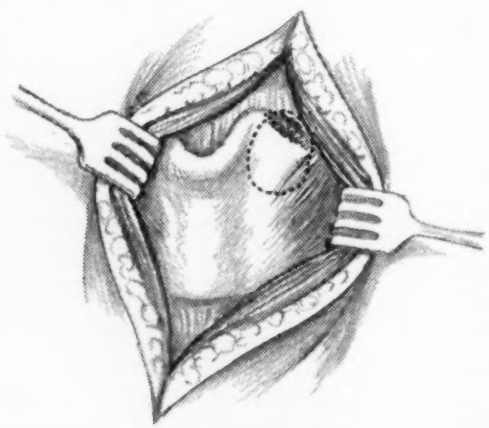

Fig. 14.—Thyroid cartilage exposed. The dotted line indicates the size of an abscess found behind a necrotic area. The probe leads into the piriform sinus.

drained through the piriform sinus. He has described a case in which this treatment was successful. The distance from the piriform sinus to the

11. Roberts, S. E.: A New Surgical Approach to the Mediastinum Through the Pyriform Sinus, Ann. Otol., Rhin. & Laryng. **44**:493, 1935.

dome of the posterior mediastinum is 6 to 7 cm. In his case of mediastinitis in a child, in which there was "pointing" in the piriform fossa, an incision 3.5 cm. deep was made in the fossa. Sixty cubic centimeters of pus was released. Roberts made investigations on dogs concerning the accessibility to the mediastinum through the piriform sinus. Iodized poppyseed oil injected into the piriform sinus of a dog was seen well down in the posterior mediastinum three hours later and followed the normal cervical curve. He was able to demonstrate that the prevertebral cervical fascial planes can easily be separated when approached from above through the piriform fossa. He stated the belief that a surgical approach to the mediastinum through the piriform sinus is entirely practical from both a clinical and an anatomic point of view. Voss [12] opened the mediastinal space in 4 cases of posterior mediastinitis through an incision of the posterior pharyngeal wall and by tearing through the strands of connective tissue with the finger in the retropharyngeal space succeeded in establishing good drainage of the mediastinum. This procedure approximately corresponds with Robert's experimental work on dogs, even though Voss did not limit himself strictly to the piriform sinus. It should therefore be kept in mind that in cases of mediastinitis in which an external operative procedure has not been satisfactory, an internal exposure, as described by Voss, may be successful.

The piriform sinus is of further interest as a channel for the lymphatics of the hypopharynx, the upper part of the larynx and part of the base of the tongue. The lymph vessels run beneath the mucous membrane of the piriform sinus and pass through the thyrohyoid membrane alongside the superior laryngeal artery to reach the deep cervical glands.[13] On their way to these, in some cases, they pass through a row of small lymph nodules which lies next to the thyrohyoid membrane (fig. 15). These lymph glands are not always present. When they are, they lie either in front of or somewhat below the hyoid bone or at times beneath the muscles radiating away from the hyoid bone. Most [14] and Poirier [15] described the presence of such glands at the upper border of the thyroid cartilage or, to be still more exact, at the lateral margin of the thyrohyoid muscle. In discussing the tumors of the piriform sinus,

12. Voss, O.: Ein einfaches aber anscheinend unbekanntes Hilfsmittel zur Eröffnung gewisser Fälle von Mediastinitis posterior, Acta oto-laryng. **26**:292-304, 1938.

13. Sappey, M. P. C.: Anatomie, physiologie, pathologie des vaissaux lymphatiques considerés chez l'homme et les vertébrés, Paris, A. Delahaye & E. Lecrosnier, 1874.

14. Most, A.: Topographie des Lymphgefässapparates des Kopfes und Halses, in ihrer Bedeutung für die Chirurgie, Berlin, A. Hirschwald, 1906.

15. Poirier, P.: Lymphatiques, Paris, Masson & Cie, 1902; Vaisseaux lymphatiques du larynx; vaisseaux lymphatiques de la portion sous-glottique; ganglion pré-laryngé, Progrès méd. (pt. 2) **5**:373, 1887.

Mikulicz and Kuemmell pointed out that "such an enlargement of the glands in the space between the thyroid cartilage and the hyoid bone must be considered as very suspicious when it occurs in older people."

I have mentioned that the piriform sinus acts as a gathering place for the lymphatics of the lower part of the pharynx and the larynx and that, as a result of this, congestive symptoms can easily be present there when the higher-lying parts, such as the hypopharynx, the base of the tongue and the larynx, are infected. With infections of the pharynx, there may be not only a swelling but real edema in the piriform sinus, and this can spread from there to the epiglottis and the remaining portions of the larynx.

Fig. 15.—Lymphatic system of the larynx, showing the piriform sinus (*A*) with lymphatics passing through the thyrohyoid membrane. *B* indicates lymph nodules near the thyrohyoid membrane (*C*). (From Sappey.[13])

At this point I should like to call attention to patients who complain of more or less severe pain on swallowing, at times long after they have recovered from infections of the throat. On examination there is definite tenderness to pressure on the lateral border of the thyroid cartilage or of the hyoid bone or to pressure over the space between them, namely the thyrohyoid membrane. Most of these patients state that the pain is not present when eating but only when they go through the motions of swallowing. Examination of the throat and larynx usually shows slight redness of the hypopharynx or of the lingual surface of the epiglottis. At times the lingual tonsil or the piriform sinus may be

swollen. The pain on swallowing and the tenderness to pressure over the area just described are often accompanied by the sensation of a foreign body being present in the throat. The explanation of these symptoms in many cases is a painful irritation of the tissues near the place where the lymphatics coming from the piriform sinus pierce the thyrohyoid membrane. In addition to this, the superior laryngeal nerve is situated close to the thyrohyoid membrane and may also easily be involved. This would cause the pain to be more severe.

Since the piriform sinus adjoins the posterior surface of the thyroid cartilage and extends to the thyrohyoid membrane anteriorly, it is easy to see that inflammations in this sinus can occasionally cause secondary infections of the upper and outer part of the throat. Von Eicken [16] described a case of this sort in which as the result of an injury to the anterior part of the piriform sinus, caused by the removal of a foreign body, an infection developed in the uppermost part of the upper pole of the thyroid gland. The infection went on to the formation of an abscess, which pointed externally.

It is well known that foreign bodies are easily impacted in the piriform sinus. Pointed foreign bodies, such as needles and fish bones, may be buried beneath the soft mucous membrane through the act of swallowing and at times are therefore invisible on examination. Boskowitz described a case in which a sewing needle could be shown in the piriform sinus only roentgenographically. He subsequently removed it through an incision in the sinus.

In 1904, Von Eicken [17] was the first to describe an unusual finding in cases of esophageal diverticulum, namely, frothing in the piriform sinus. In America, Chevalier Jackson greatly stressed this finding in diseases of the esophagus, and it is called the "Jackson sign." Other authors (Oppikofer,[18] Györgyi,[19] Freystadtl,[20] Wagener [21]) have noticed this frothing in the following diseases, in all of which there is more or less disturbance in swallowing: aortic aneurysm, substernal thyroid,

16. Von Eicken, C.: Schilddrüsenabszess nach Verletzung des Sinus pyriformis, Ztschr. f. Hals-, Nasen- u. Ohrenh. **21**:156-161, 1928.

17. Von Eicken, C.: Die klinische Verwertung der direkten Untersuchungsmethoden der Luftwege, Arch. f. Laryng. u. Rhin. **15**:372-494, 1904.

18. Oppikofer, E.: Die diagnostische Bedeutung der Schaumbildung in den Sinus piriformes bei Speiseröhrendivertikel, Cor.-Bl. f. schweiz. Aerzte **47**:1133, 1917.

19. Györgyi, G.: Die diagnostische Bedeutung der Pharynxtaschenfüllung, Fortschr. a. d. Geb. d. Röntgenstrahlen **46**:422-427, 1932.

20. Freystadtl, B.: Kehlkopf und Rachen in ihren Beziehungen zu den Erkrankungen des Zentralnervensystems, Berlin, S. Karger, 1928.

21. Wagener, O.: Zur Diagnose der Schlucklähmungen, Beitr. z. prakt. u. theoret. Hals-, Nasen- u. Ohrenh. **10**:230-234, 1918.

tumor of the esophagus, esophageal varices and bulbar paralysis. I myself have often seen definite frothing with diseases of the esophagus, with bulbar paralysis and with substernal thyroid. In some cases of progressive bulbar paralysis, the presence of frothy saliva in the piriform sinus is the first indication that swallowing is impaired. The patients themselves do not complain of difficulty in swallowing in the early stages of this disease, and it is only on questioning that they realize that there has been some disturbance, as evidenced by a sensation of the food sticking in the throat, which necessitated the drinking of fluids to wash it down. The extent of the disability to swallow can be estimated objectively when the symptom of frothing in the piriform sinus is observed. This can be best demonstrated by having the patient drink milk. When swallowing is normal, the piriform sinus is completely empty after a few minutes. When swallowing is disturbed, the blue-white color of the milk is still visible even after a prolonged interval. In healthy persons, frothing in the piriform sinus is never marked, if it is at all present, and it varies from time to time in the individual.

In my experience this sign is a valuable early indication that there is a disturbance in swallowing. In a number of patients, my attention was called by this sign to the impairment of swallowing even before the patients themselves were at all aware of such disturbances. Some authors [22] have attempted to explain the mechanism of frothing in the piriform sinus, but, as there has been no unanimity of opinion among them, I should not like to discuss it further.

At this point I should like to touch briefly on the methods of examining the piriform sinus. In general, examination with the mirror suffices. When there is any doubt, however, as to pathologic changes, especially when malignancy is suspected, a direct examination should be made. Pathologic changes are most easily overlooked on the medial surface beneath the arytenoids, in other words, in the deepest part of the piriform sinus. The reason for this is that the arytenoid cartilage and the aryepiglottic fold often form a deep, sharp angle with the piriform sinus, and one cannot always see into this angle with the mirror alone. In such cases the arytenoid cartilage and the aryepiglottic fold must be pushed aside medially. This is best accomplished by means of the direct laryngoscope of Jackson. One is often amazed how extensive some changes, especially those due to tumors, may appear, which on examination with the mirror were at first not too obvious. The early recognition of malignant diseases depends to a large extent on a thorough examination of the piriform sinus.

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22. Gerlings, P. G., and den Hoed, D.: The Significance of the Stagnation of Secretion in the Valleculae Glossoepiglotticae and in the Sinus Pyriformes, Acta oto-laryng. **22**:519-528, 1935.

At the Paris Cancer Institute it has been found that 60 per cent of the tumors of the hypopharynx originate in the piriform sinus. Some are radiosensitive and show but little tendency to extension, whereas others are malignant. Most of the cancers of the piriform sinus are particularly dangerous because of their glandular metastases. The patients usually come for treatment only when difficulty in swallowing has developed, a symptom which indicates an extension to the pharyngeal wall. One should be suspicious of a beginning cancer of the piriform sinus in patients of advanced age with complaints of tickling in the throat and a frequent desire to clear it.

I have already mentioned that the majority of the lymphatics of the larynx, especially of its upper part, pass through the piriform sinus. This fact seems to me of importance in considering the metastases of malignant tumors of the larynx, particularly in cases in which a decision must be reached whether a growth is intrinsic or has already spread and must be considered extrinsic. Until now one has been guided by whether the cervical glands were palpably involved, whether some other change in the larynx could be seen or, finally, whether a softening or hardening of the laryngeal skeleton could be felt on palpation. Jackson has stressed that it is most important to palpate the outer surface of the thyroid and cricoid cartilages thoroughly in search for such changes and that the presence of a prelaryngeal gland on the cricothyroid ligament must be sought, a gland which is frequently overlooked. I believe one can add another examination to these, namely, a thorough examination of the piriform sinus.

It is important at this point to discuss once again the lymphatics of the larynx, especially those of its upper portion. The lymph drains off through four or five vessels that pierce the wall of the larynx beneath the aryepiglottic fold and then run past the arytenoid cartilage (fig. 15). All these lymph vessels continue beneath the mucous membrane of the piriform sinus and along the superior laryngeal artery through the thyrohyoid membrane to the outside. There, in many cases, they pass through one or more small lymph nodules which are a part of the chain of deep cervical glands and which were described earlier in this paper.

It must be assumed that the malignant cells reach the cervical glands through the lymphatic system of the piriform sinus. One must further assume that the lymphatic system of the piriform sinus is already involved with carcinoma in many cases, even before such involvement is apparent on superficial examination and before it can be demonstrated in the cervical glands. It is therefore of great importance to determine whether an intrinsic tumor of the larynx has already implanted itself in the piriform sinus. In this respect the following changes in the piriform sinus should be considered and looked for. The larynx may deviate

toward the uninvolved side when the submucous tissue in the piriform sinus is already infiltrated, even though the infiltration is minimal. It is therefore important to examine the position of the larynx in relation to the lateral pharyngeal wall. This is measured mainly by the distance between the aryepiglottic fold and the lateral pharyngeal wall on each side. In a similar way the depths of both piriform sinuses can be compared. Because of the infiltration of the piriform sinus, its floor may be raised and it may appear more shallow. Such changes are sometimes slight and cannot be seen on examination with the mirror. For this reason I have already recommended examining the piriform sinus by the direct method or even palpating it with the finger. With the area under carefully induced local anesthesia, the index finger can be inserted into the larynx and the tissues of the piriform sinuses comparatively palpated for changes and thickenings. In the same way, the thyrohyoid membrane can be palpated through the piriform sinus for possible infiltrations, and the presence or absence of small carcinomatous glands on or to the side of the thyrohyoid membrane can be determined, if the membrane is palpated from the inside through the piriform sinus and at the same time from the outside with the other hand. To summarize briefly, the following findings in an examination of the piriform sinus for possible malignant infiltrations should be considered:

1. Deviation of the larynx to one side.
2. Enlargement of the diseased piriform sinus.
3. Shallowness of the piriform sinus through bulging of its floor.
4. Hardening of the thyrohyoid membrane.
5. The presence of small glands on and to the side of the thyrohyoid membrane.

CHONDROMA OF THE ETHMOID

WITH REPORT OF A CASE

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Chondroma of the ethmoid attracts the attention of clinician and pathologist alike—the former because of its bizarre course and symptoms; the latter because of its comparative rarity. Chondroma is rare in any region of the body but is found least frequently in the nose and accessory sinuses. The minimal incidence of such neoplasms is attested by Geschickter [1] in a classification of 211 tumors of the nasal and paranasal cavities, selected from over 2,000 specimens removed surgically at the Johns Hopkins Hospital. In this series there were 19 benign epithelial tumors, 139 malignant epithelial tumors, 37 benign tumors of connective tissue (exclusive of 76 osteomas) and 16 sarcomas. The benign tumors of connective tissue consisted of angioma, plasmocytoma and fibroma; no case of chondroma was found.

Enchondroma, a cartilaginous tumor within a cavity, was first described by Müller,[2] in 1836. Virchow [3] in 1857 created the term myxoma and divided soft enchondromas into myxomatous enchondroma, in which cartilage predominates, and cartilaginous myxoma, in which mucous tissue is more abundant. In 1868 Trerneuil [4] reported a case of myxomatous enchondroma arising from the ethmoid of a boy aged 11 years. In McAuliffe's [5] case myxochondroma in the nose of a child 8 months old did not appear to involve the ethmoid except by possible secondary invasion, as it arose from the inferior turbinate and extended upward to involve the lateral nasal wall and the anterior wall of the maxillary sinus. Observations on 29 cases collected by Sicard [6] in 1897

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1. Geschickter, C. F.: Tumors of the Nasal and Paranasal Cavities, Am. J. Cancer **24**:637 (July) 1935.

2. Müller, J.: Rede zur Feier des zwei und vierzigsten Stiftungstages des königlichen, medicinisch-chirurgischen Friedrich-Wilhelms-Instituts, Berlin, Gebrüder Unger, Aug. 2, 1836.

3. Virchow, R.: Ein Fall von bösartigen, zum Theil in der Form des Neuroms auftretenden Fettgeschwülsten, Virchows Arch. f. path. Anat. **11**:281, 1857.

4. Trerneuil, cited by Uffenorde.[7]

5. McAuliffe, G. W.: Myxochondroma in the Nose of a Child Eight Months Old, Laryngoscope **48**:206 (March) 1938.

6. Sicard, J.: Des tumeurs cartilagineuses (enchondromes) des fosses nasales, Paris, J. B. Baillière & fils, 1897.

are not strictly applicable to the subject of this discussion, as the majority of the growths were enchondroma of the septum or a mixed tumor of extranasal origin.

Uffenorde [7] in 1908 recorded the removal by "paranasal rhinotomy" of a chondroma arising from the ethmoid of a woman aged 21. During three months proptosis, diplopia, nasal obstruction and unilateral headache had developed, and the mass could be seen by posterior rhinoscopy as well as under the middle turbinate anteriorly. The histologic diagnosis was chondroma with myxomatous degeneration. Supplementing the case report Uffenorde stated that chondroma is a rare tumor in the nose, liable to malignant degeneration; it makes its appearance before the age of 25, affects the two sexes equally and grows most often from the ethmoid.

Paradzik [8] reviewed the report by Schlittler of 51 collected instances of nasal chondroma and reported 1 of his own, as well as a septal chondroma described by Cemach and 2 enchondromas of the ethmoid, described by Fraser and by Klaue.[9] His own case was that of a large firm chondroma in a man 45 years of age; the duration of only six months was considered unusual. Arising from a rather broad base, the tumor took in the entire ethmoid area, filled the antrum and canine fossa and deflected the nasal septum toward the opposite side; the sphenoid sinus and the orbit were not involved. The patient had been free of recurrence for six months when last seen.

Howarth [10] contributed to the knowledge of the subject, although his particular case was one of septal involvement. He stated: "The . . . case would seem to be worthy of record since chondroma is one of the rarest of intranasal tumors and the recorded cases are singularly few in number." He referred to the work of Heymann,[11] and considered the tumors best explained as arising from "cartilaginous rests" that may occur when the area is undergoing ossification.

Hopmann [12] described a case of enchondroma arising from the ethmoid, encroaching on the septum and filling the sphenoid; the pos-

7. Uffenorde, W.: Die Chondrome der Nasenhöhle und Mitteilung eines Falles von Enchondrom des Siebbeins, Arch. f. Laryng. u. Rhin. **20**:255, 1908; abstracted, J. Laryng., Rhin. & Otol. **23**:269 (May) 1908.

8. Paradzik: Ueber ein Chondrom des Siebbeins, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:505, 1929.

9. Klaue, H.: Ein Chondrom des rechten Siebbeines, Ztschr. f. Laryng., Rhin., Otol. **13**:121, 1924-1925.

10. Howarth, W.: Chondroma of the Nasal Septum, J. Laryng., Rhin. & Otol. **45**:191 (March) 1930.

11. Heymann, P.: Handbuch der Laryngologie und Rhinologie, Vienna, A. Hölder, 1900, vol. 3, p. 851.

12. Hopmann, E.: Enchondrom des Keilbeins, der Siebbeine und der Nasenscheidewand, Ztschr. f. Laryng., Rhin., Otol. **21**:454 (Aug.) 1931.

terior wall of the latter was destroyed. The symptoms were headache, partial anosmia, visual disturbances and proptosis of the right eye. Surgical removal of the tumor gave a good cosmetic result and uneventful recovery.

Lugli [13] in 1931 published a monograph containing a review of the literature to date and the report of a case of ethmoid chondroma in a girl aged 11 years. He also discussed the incidence, origin and extension of the neoplasm, the symptoms, the diagnosis and the differential diagnosis, especially from osteoma, mucocele and suppurative ethmoiditis with orbital perforation. The gross and microscopic pathologic picture, as well as the surgical treatment, were covered in great detail. He emphasized that, while classed as a benign tumor histologically and biologically, chondroma of the ethmoid may appear clinically nonbenign and dangerous to the patient; growth is by compression of bony structures rather than by infiltration; the course is slow—in one case twenty-five years—and there is a marked tendency to recur. Citelli is cited as including the condition in a separate group of tumors of intermediate gravity, along with osteoma, adenoma and papilloma, rather than with frankly benign tumors.

Rubaltelli [14] reported the successful removal of a walnut-sized chondroma from the left ethmoid of a 16 year old carpenter. For about five months prior to admission to the clinic there had been progressive external deviation, exophthalmos and marked loss of vision of the left eye. A hard, fixed, painless mass was palpated in the superomedial angle of the orbit, and a corresponding bulging was noted intranasally. Operation, with the area under local anesthesia, was performed by the centrofacial approach of Citelli; the frontal and maxillary sinuses had to be opened to remove aseptic mucoceles which came to view while the tumor was displaced, but these cavities did not contain chondroma. An excellent cosmetic result was seen after seventeen months, and there was no recurrence.

To a comprehensive survey of the available literature, Menne and Frank [15] added a report of a case of slow progressive development of chondroma in a laborer aged 44; the growth was not recognized until it had invaded the left orbital cavity, and when finally presented for treatment it was inoperable, the total course having been four and one-half years. The tumor studied by roentgenographic examination and

13. Lugli, G.: Condroma dell'etmoide, Arch. ital. di laring. **50**:135 (June) 1931.

14. Rubaltelli, E.: Voluminosa condroma etmoidale sinistro con mucocele pan-sinusale e grave sindrome oculare, Riv. oto-neuro-oftal. **14**:48 (Jan.-Feb.) 1937.

15. Menne, F. R., and Frank, W. W.: So-Called Primary Chondroma of the Ethmoid, Arch. Otolaryng. **26**:170 (Aug.) 1937.

at autopsy was shown to involve, besides the orbits, the septum, palate, nasopharynx, cribriform plate and cranial cavity. The authors pointed out that the exact origin of such tumors frequently cannot be determined when they are seen in later stages of development; they suggested a plausible theory of origin in the processus sphenoidalis septi cartilaginei and questioned the ethmoid origin of true chondroma.

It is evident, then, that chondroma of the ethmoid shows a predilection for young patients, chiefly between the ages of 10 and 25 years. In my case, presented hereafter, the symptoms were first noticed by the patient at the age of 41, although the characteristic slow growth may indicate that the actual origin was years earlier. Trauma has not been shown to be a factor as with osteoma and mucocele. Development takes place in bony areas during the active growth of the person, from "cell rests." Although nonmalignant, chondroma in this region tends to recur; this clinical habit may be attributed partially to the fact that complete surgical extirpation cannot always be accomplished, the apparent recurrence being in reality proliferation of remaining tissue. Symptoms suggesting involvement of the orbit invariably predominate, nasal obstruction being secondary and occurring later in the course of the disease.

Because of the relative rarity of the condition and the complications which may intervene in its course, it seems desirable to set down the following experience with a patient in whose case the clinical picture extended over sixteen years.

REPORT OF CASE

Mrs. E. C., aged 56, was referred by an oculist on Nov. 30, 1936 for treatment of an orbital abscess which seemed to be related to disease of the accessory sinuses. Her past history was interesting; with the exception of a gastric operation in 1934, all her previous illnesses had been referable to the region of the head. In September 1921 she had consulted the late Dr. W. C. Bane on account of a hard mass about 1 cm. in diameter, located on the left infraorbital rim below the ocular caruncle; it was apparently connected with a similar mass attached to the upper lateral nasal wall, extending medially to contact the septum and disappearing on external pressure when the intranasal portion was removed. A pathologic section was reported as showing chondroma.

No further symptoms developed until 1927, when similar areas appeared on the lateral nasal wall and in the ethmoid region and were removed by the intranasal route. At this time the tissue removed was softer, and pathologic examination of fragments showed myxomatous tissue infiltrated by polymorphonuclear leukocytes and lymphocytes; the diagnosis was infected myxoma.

Again there was comparative freedom from symptoms for six years; in 1933, an abscess developed in the canine fossa and was incised infralabially; about a month later it was deemed advisable to perform a Caldwell-Luc operation on

the left antrum to facilitate the removal of a cartilaginous mass involving the ethmoid and the upper part of the antrum and encroaching on the nasal septum sufficiently to push it noticeably to the right. An abscess was encountered on the lateral wall of the antrum beneath the mucosa. An intranasal opening was made in the middle rather than the inferior meatus. Sections of tissue removed at this time were diagnosed pathologically as fibrochondroma. Residual masses of cartilage were removed from the lower orbital rim four months later.

The sinal condition remained quiescent, but in 1934 purulent dacryocystitis made its appearance on the left side; this was relieved by repeated lacrimal irrigations, but it was impossible to pass a probe from the nasolacrimal duct into the nose, and lacrimation continued from that time. A probe could be passed into the antrum through the middle meatus at the site of a former antrotomy.

In August 1936 there was swelling of the left upper eyelid, which progressed to a definite orbital abscess (fig. 1); this was incised by the family physician and later by the oculist, drainage continuing intermittently for more than three

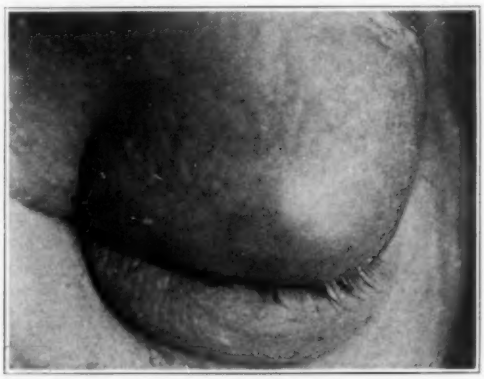

Fig. 1.—Orbital abscess, seventh day, secondary to obstruction of the frontal sinus caused by chondroma.

months from an opening below and lateral to the midportion of the brow. It was at this point in a rather lengthy train of events (Nov. 30, 1936) that the patient first presented herself to me.

Examination disclosed a woman somewhat beyond middle age, in a good state of general health, with a fistulous opening in the left upper lid, through which a probe could be passed into the floor of the left frontal sinus. The intranasal examination revealed a straight septum with no evidence of tumefaction; the right side of the nose was normal; a portion of the left middle turbinate was absent. High in the ethmofrontal recess a small opening was noted, which, on being probed and dilated with frontal sinus sounds, established a communication via the nasofrontal duct with the frontal sinus; this was verified by cross probing from the fistulous opening in the brow. A large amount of gelatinous material was evacuated from the intranasal opening and good drainage established, with the result that within a few days the external wound closed.

Roentgen examination of the sinuses on December 12 was reported as follows: "Both frontal sinuses are well developed and lobulated by incomplete partitions; the right is clear; the left shows increased density in its superior medial portion and toward the outlet. The right ethmoid is clear; the left shows increased density, especially in the portion adjoining the orbit; the contour of the upper inner margin of the orbit is lost. The right antrum is clear; the left is clear except in the upper inner angle, where increased density is superimposed from the ethmoid. The sphenoid sinuses are clear."

In view of the failure of previous intranasal procedures to relieve permanently a condition which was obviously becoming more extensive, external operation was advised. However, the patient, delighted over the clinical improvement, including the cessation of the lacrimation present continuously for two and one-half years, declined operation. There followed during the next nine months a series of some four or five episodes of a few days' duration when sudden swelling appeared in the orbit, followed by spontaneous reopening of the fistulous tract and evacuation of an abscess, with partial resolution. These attacks transpired in spite of an unchanged intranasal condition, a nasofrontal duct which admitted a no. 14 (French) sound and no headache. About May 1, 1937, a definite bulge appeared in the superomedial angle of the orbit, and this area, tense in character, continued to become more prominent; on palpation the mass revealed a "celluloid-like" feeling similar to that characteristic of mucocele.

Finally, when the economic hazards incident to hospitalization and operation had been overcome, the patient was admitted to Colorado General Hospital on October 23, with a diagnosis of chronic ethmoid and frontal sinusitis on the left side, recurrent orbital abscess and tumor of the left ethmoid. On admission, the temperature was normal; the pulse rate, 80, and the blood pressure, 140 systolic and 100 diastolic; a slight systolic blowing murmur limited to the cardiac apex and a healed operative scar in the midline of the abdomen were the only abnormal physical findings aside from those referable to the ethmofrontal region. Examination of the blood showed mild secondary anemia; the urine was normal.

After preliminary medication with barbiturates followed by hypodermic injection of scopolamine and morphine, orbital block anesthesia was accomplished with a 2 per cent solution of procaine hydrochloride and epinephrine hydrochloride; this was supplemented by a 5 per cent solution of cocaine hydrochloride administered intranasally for surface anesthesia. Through a ½ inch (1.3 cm.) incision a modified Lynch operation was performed. There was a hard cystic swelling, 1.5 cm. in diameter, in the region of the floor of the left frontal sinus and the left ethmoid, to the nasal side and above the inner canthus; the floor of the frontal sinus and the external wall of the ethmoid were found to be necrosed by the tumor and suppuration; the frontal sinus and the ethmoid cells revealed chronic thickened membrane and contained free pus.

The operation consisted of removal of the tumor and its limiting capsule, with exenteration of all accessible ethmoid cells, removal of the floor of the frontal sinus and evisceration of the lining frontal mucosa; a large iodoform oiled gauze pack was carried from the ethmofrontal cavity into the nose; the wound was closed with fine dermal sutures. The packing was removed on the second day and the sutures taken out on the fourth day, at which time the patient left the hospital; periocular edema subsided rapidly, and healing was well established at the end

of ten days. The end result may be best determined by the photograph (fig. 2) taken six months postoperatively. It is now two years since the operation; the chondroma has not demonstrably recurred, and all sinal suppuration has ceased.

The report of a pathologic examination of tissue was as follows:

"The gross specimen was 1.5 Gm. of reddish gray soft tissue and 1.5 Gm. of reddish gray bony spicules filled with honey-combing.

Fig. 2.—Healed scar of ethmofrontal operation on the left, six months postoperatively.

Fig. 3.—Low power photomicrograph, showing the inflammatory reaction at the border of the chondroma.

"Microscopic examination of the soft material was carried out on 5 sections. Cells with round nuclei containing granular blue chromatin and well defined nucleoli have a pink granular cytoplasm shrunken away from the cell wall. These cells appear to be secreting a dark and a light blue foamy material, which with the cells are enclosed in a collagen fibril envelope, overlying which is a covering of pseudostratified columnar ciliated epithelium. The collagen fibrils show spreading

apart in a few areas and infiltration of round and plasma cells in many areas. A few bony spicules infiltrated by dark blue material are also present.

"The specimens of decalcified bone were examined in 4 sections. The marrow of the bone shows proliferation of connective tissue and infiltration by nests of plasma cells. The dense connective tissue overlying the bone is heavily infiltrated by round cells. A few acini lined by cuboidal epithelium are embedded in the stroma, which is covered over by a pseudostratified ciliated epithelium. A portion of homogeneous substance, described in the preceding paragraph, lies contiguous to the bone.

"The pathologic diagnosis is chronic ethmoiditis and submucous chondroma."

Photomicrographs of the sections of tissue are shown in figures 3 and 4.

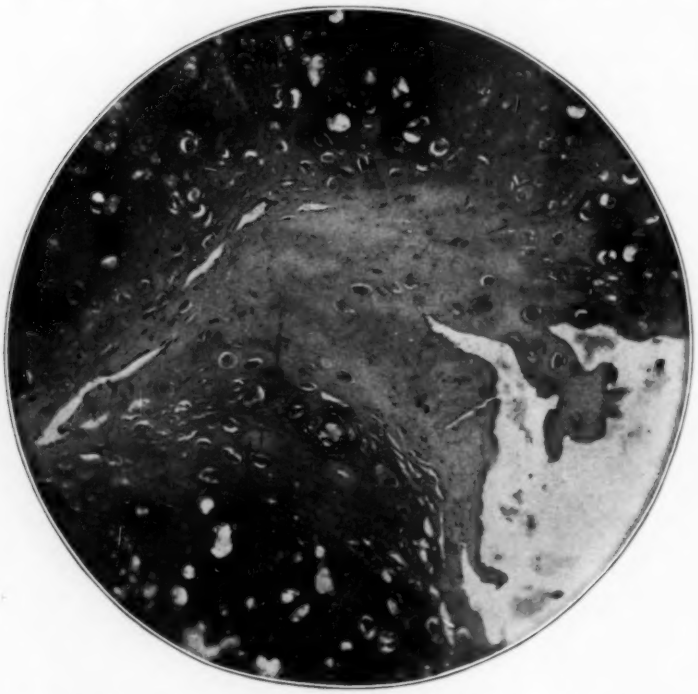

Fig. 4.—High power photomicrograph, showing the area of atypical cartilage comprising the tumor.

SUMMARY

Chondroma of the ethmoid, a rare intranasal tumor, is discussed and the rather limited pertinent literature reviewed. A case is reported in which the neoplasm was an important contributing factor in the production of orbital abscess and suppuration of the frontal sinus; operation resulted in an apparent cure of the original condition and all the related complications.

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CONGENITAL ATRESIA OF THE POSTNASAL ORIFICES

A SIMPLE, EFFECTIVE OFFICE TECHNIC FOR TREATMENT BY ELECTROCOAGULATION

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Congenital atresia of the postnasal orifices is due to the failure to disappear of normally occurring embryonic structures. The theories of its formation ascribe it to (*a*) the persistence of the bucconasal membrane, (*b*) the persistence of the buccopharyngeal membrane or (*c*) the overgrowth of the horizontal and vertical processes of the maxillas.

Schaeffer [1] described the formation and the disappearance of the bucconasal membrane as follows:

> Thirty-five (35) day embryos show that the nasal pits have deepened sufficiently to partake of the nature of cleft-like fossae. . . . The fossae communicate freely with the exterior by means of the nares (anterior nares) but in the absence of choanae (posterior nares) end blindly at their dorsal and inferior termination. . . . The dorsal growth or extension of the blind, pouch-like primitive nasal fossae meets the ectoderm of the oral fossa. One now finds in these positions the bucconasal membranes composed of two layers of abutting epithelium (nasal and oral), separating the dorsal portion of the primitive nasal fossae from the oral cavity. In 35 to 38 day embryos the membranes are so attenuated that rupture ensues and the primitive choanae (primitive posterior nares) are thus established and with them communication between the nasal fossae and the oral cavity. Lack of rupture of the bucconasal membrane leads to atresia of the choanae. . . .
>
> The amount of mesenchymal tissue remaining between the nasal and the pharyngeal mucous membranes determines whether the atretic mass is to be membranous, osseous or combinations of these. The thickness of the obstructing mass depends, of course, on the degree of dorsal growth of the nasal fossae and the extent of the resorption of the mesenchyme between the nasal and the pharyngeal epithelia.[2]

It appears certain that some thin, atretic membranes located in the region of the choanae rupture spontaneously during the early days of infancy, leaving little, if any, evidence of the obstruction.

1. Schaeffer, J. P.: The Various Types of Congenital Atresia of the Nose and Their Genetic Interpretation, in the Nose, Paranasal Sinuses, Nasolacrimal Passageways, and Olfactory Organ in Man, Philadelphia, P. Blakiston's Sons & Co., 1920, pp. 7-10.

2. Schaeffer, J. P.: Various Types of Congenital Atresias of the Nose and Their Genetic Interpretation, Tr. Am. Laryng. A. **56**:126, 1934.

The choanae are bounded medially by the posterior border of the septum and the nasal crest of the palatal bone, above by the alae of the vomer and the body of the sphenoid bone, laterally by the median plates of the pterygoid processes of the sphenoid bone and the perpendicular plate of the palatal bone and below by the horizontal plate of the palatal bone.

Most writers agree that such choanal atresia is a congenital defect and not a pathologic condition. It is a comparatively rare developmental anomaly. The first occurrence was noted at necropsy by Otto, of Breslau, in 1829.[3] Emmert,[4] in 1853, first recognized and successfully operated to relieve bilateral choanal atresia, in a boy of 7 years. Since then the condition has been reported with increasing frequency, particularly during the past two decades, a tribute to the increased number of well trained workers in rhinology and to the more widely diffused knowledge that such a deformity may occur. At the present time nearly 200[5] cases have been recorded in the literature.

In the otorhinolaryngologic department of the Royal Infirmary of Edinburgh during twenty years (1907-1926) 27,863 patients were given nasal examinations and among these 6 (0.02 per cent) with unilateral atresia were found.[6] Congenital bilateral occlusion is more rarely reported because it often results in death from asphyxia at birth and thus remains unrecognized.

Stewart[6] reported on 2 patients with bilateral congenital atresia in one family, sisters 18 and 15 years old. An infant brother had died within forty-eight hours after birth, being bluish and dyspneic. It is likely, he stated, that his was a third case in the family.

Phelps[7] did not regard choanal atresia as hereditary, despite another recorded case, in which, in one family, a mother, her 2 sisters, 2 daughters and a son all had this malformation.

If unilateral or if bilateral but incomplete, the occlusion may escape detection by the patient, the parents and the examining physician for many years. Repeated adenoidectomies and occasionally ineffectual intranasal procedures have been carried out without the true nature of

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3. Otto, A. W.: A Compendium of Human and Comparative Pathologic Anatomy, translated by J. F. South, London, B. Fellowes, 1831; cited by von Schroetter.[17]

4. Emmert, C. F.: Lehrbuch der Chirurgie, Stuttgart, F. and R. Dann, 1853; cited by von Schroetter.[17]

5. (*a*) Lebensohn, J. E.: Congenital Atresia of Postnasal Orifices, Ann. Otol., Rhin. & Laryng. **32**:1128 (Dec.) 1923. (*b*) Cavanaugh, in discussion on Lebensohn.

6. Stewart, J. P.: Congenital Atresia of the Posterior Nares, Arch. Otolaryng. **13**:570 (April) 1931.

7. Phelps, K. A.: Congenital Occlusion of Choanae, Ann. Otol., Rhin. & Laryng. **35**:143 (March) 1926.

the occlusion being discovered.[8] On the other hand, complete bilateral occlusion can cause alarming asphyxia in the newborn. The instinct for nasal breathing in the newborn is so impelling that unless the mouth is forced open or the choanal occlusion is immediately broken through asphyxia may result. It is the opinion of many writers[9] that surely a number of the deaths listed as "asphyxia neonatorum" have been caused by unrecognized, complete, bilateral choanal occlusion. If an infant with bilateral choanal obstruction should somehow succeed in breathing through the mouth, the chances of its survival are lessened by interference with suckling and consequent malnutrition. Nevertheless, a standard textbook on obstetrics, by Williams,[10] and one on pediatrics, by Holt and Howland,[11] do not mention the condition. Had its possibility been kept in mind, many infant lives might have been saved.

In the newborn or in young infants, palpating with a probe or attempting to blow air through either nostril with a rubber bulb will help make the correct diagnosis. When the occlusion is membranous, rupture with a probe and dilation with the back of a small mastoid curet may give a satisfactory result.[12] In a case of unilateral occlusion, the mother may notice that the child can nurse only while lying on the obstructed side so that the patent nostril is above and not blocked by venous congestion caused by gravity. Complete stenosis of one or both nostrils in such young patients is never due to adenoids.[5b] This is important, as in some cases the true condition has been overlooked and the sufferer operated on three times for alleged adenoids.

Cavanaugh[5b] reported the case of a 12 year old child whose tonsils and adenoids had been removed, the latter on three occasions. The inferior and middle turbinates had been excised, and the attending physician was reported to have considered an operation on the ethmoid sinuses on the affected side of the nose. When the correct diagnosis of unilateral choanal atresia was finally made, the discouraged mother declined to permit the necessary operation.

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8. (*a*) Footnote 5. (*b*) Wright, A. J. M.: Congenital Bilateral Occlusion of Choanae, J. Laryng. **37**:556 (Nov.) 1922. (*c*) Colver, B. N.: Congenital Choanal Atresia: Two Cases of Complete Bilateral Obstruction, Ann. Otol., Rhin. & Laryng. **46**:358 (June) 1937.

9. (*a*) Footnote 5. (*b*) Clarke, J. P.: Complete Congenital Occlusion of the Posterior Nares, Boston M. & S. J. **138**:171 (Feb. 24) 1898. (*c*) Richardson, C. W.: Congenital Osseous Obstruction of the Post-Nasal Orifices, Ann. Otol., Rhin. & Laryng. **22**:488 (June) 1913. (*d*) Ronaldson, T. R.: Note on a Case of Congenital Closure of the Posterior Nares, Edinburgh M. J. **26**:1035, 1880-1881.

10. Williams, J. W.: Obstetrics, ed. 5, New York, D. Appleton and Company, 1924.

11. Holt, L. E., and Howland, J.: Diseases of Infancy and Childhood, ed. 9, New York, D. Appleton and Company, 1926.

12. Lemere, H. B.: Persistent Bucconasal Membrane in the New-Born, J. A. M. A. **109**:347 (July 31) 1937.

The sense of smell is diminished in unilateral obstruction, and anosmia occurs in the bilateral condition. Sense of taste is similarly diminished. The voice is nasal. Slight asymmetry of the face can be observed in cases of unilateral obstruction. The hearing may be affected in the bilateral condition.

The impervious nostril is often filled with thick, glary, tenacious mucus. This usually is mixed with the lacrimal secretion, which empties into the nose. The patient, being unable to blow the nose, is generally obliged to remove this discharge by syringing. When the patient cries, some of the tears flow out through the nose. When the head is tilted forward, as in eating, these secretions drip down through the nose, causing annoyance and embarrassment. Erosion of the nares and of the upper lip may be present. In the unilateral condition tobacco smoke can be exhaled through the patent nostril only. (This phenomenon was utilized by my patient as a parlor trick.) Of course, it is impossible to syringe fluids through the occluded nostril into the pharynx or into the other nostril or to force air through the blocked nasal passage with a rubber bulb. Postnasal examination by finger palpation, by a mirror or by a nasopharyngoscope passed through the mouth reveals the abnormality. Finger palpation is impossible in the average infantile throat.[13] If the obstructing tissue is visible from the front, it is seen to be pale and gray. In the postnasal mirror it may appear pinkish and often dimpled and perforated in the middle if the obstruction is incomplete. The nasal chambers are wide because of underdevelopment of the turbinates. The mucosa is paler than normal and is often waterlogged. The occluding wall, if bony, may be up to 12 mm.[13] thick and is usually situated near or even with the posterior margin of the vomer.

In differential diagnosis[13] the following conditions should be ruled out:

1. Adenoids.
2. Congenital postnasal polyp or tumor.
3. Intranasal occlusion due to polyps, bony and cartilaginous obstructions or new growths.
4. Cicatricial stenosis of the nasopharynx due to (*a*) tonsillectomy, (*b*) tonsillectomy and adenoidectomy, (*c*) hereditary syphilis, (*d*) acquired syphilis, (*e*) diphtheria, (*f*) rhinoscleroma, (*g*) tuberculosis, (*h*) caustic burns, for instance, by sulfuric acid, (*i*) indeterminate inflammatory processes, (*j*) nonoperative trauma or (*k*) a foreign body in the nose.

Surgical opening of the bony occlusion is accomplished by the use of one or a combination of the following instruments: a Kraus trocar, an antrum drill, a nasal punch forceps, a dental burr or a chisel and

13. Garretson, W. T.: Congenital Occlusion of Choanae, with Report of Two Cases, Laryngoscope **37**:263 (April) 1927.

hammer. If a general anesthetic is used, the left forefinger inserted into the postnasal space touching the posterior surface of the obstruction acts as an invaluable guide in properly placing the instruments. This permits the complete destruction required without injury to the posterior nasopharynx or to the blood vessels and nerves lying just outside the lateral margin of the obstruction. It is a requisite for success to remove not only the occluding diaphragm but also a fair piece of the posterior margin of the septum. This expedient was first suggested by Katz.[14] It was successfully employed by White[15] in reoperating on a patient of his in whom the first opening he made was practically closed in three months. In removing the occlusion, care should be taken not to injure the pterygopalatine canal, which is situated just anterior to the choanal orifice, or the posterior palatine canal, situated just behind the opening in the outer wall. In older patients the normal osseous development around the choanal canal has been retarded. For this reason, special care must be exercised in working laterally to avoid injury to the blood vessels and nerves in the canals here situated.[15a] As much care as possible should be taken to prevent the aspiration of bone chips covered with blood.

With a local anesthetic, the employment of the left forefinger as a guide is not feasible, but there is some compensatory advantage in the material reduction of the danger of aspiration of bone chips. It is wiser to avoid enlarging the opening in the obstruction too much laterally, to insure the safety of the blood vessels and nerves located there.

All sorts of ingenious devices have been tried postoperatively in an effort to maintain the patency of the surgically made opening. Rubber tubes and obturators were left in place for many days; tubes of blocked tin,[16] molded to shape and inserted into the opening, were worn for six weeks. A long gauze strip covered with bismuth paste was looped through the opening from one side of the nose to the other. A fresh piece of such gauze, sewed to the end of the old, was pulled through the newly made opening and the dressing thus changed daily for ten days.[16a]

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14. Katz, L., in Katz, L.; Preysing, H., and Blumenfeld, F.: Handbuch der speziellen Chirurgie des Ohres und der oberen Luftwege, Würzburg, Curt Kabitzsch, 1911-1913, vol. 3, p. 432; quoted by White.[15]

15. White, L. E.: An Operation for Bony Occlusion of the Posterior Nares, Laryngoscope **28**:571 (Aug.) 1918.

15a. Stinson, W. D.: Osseous Atresia of Posterior Choanae, Arch. Otolaryng. **15**:101 (Jan.) 1932.

16. Hubbell, A. A.: Congenital Occlusion of the Posterior Nares, Buffalo M. & S. J. **26**:5, 1886.

16a. Brady, A. J.: Atresia of the Choanae: A Simple Device for Prevention of Re-Formation of the Obstruction After Its Removal, J. Laryng. **33**:49 (Feb.) 1918.

Electrocautery was used as early as 1885.[17] Many chemical caustics, for example, potassium hydroxide and trichloroacetic acid, have been tried for some months after operation in an attempt to control the granulation and synechia. Clipping the edges of the opening with a sphenoid punch forceps has been advised for the same purpose. Recently, Donnelly [18] placed a full thickness skin graft stitched to a no. 18 woven catheter against the raw, bony surface of the choanal opening and left it in place for ten days.

Small wonder that such painful and prolonged postoperative procedures resulted in many accidents, such as infection of the middle ear, severe hemorrhage and even occasionally death. As has been stated, the failure of operations for bony choanal occlusion is due to the reformation of the occluding tissue, often in a few months. Since the operator encounters only 1 or 2 cases in a lifetime, he has scarcely the opportunity for observing and evaluating the different methods of operative procedure.

In sharp contrast with these surgical procedures, with their difficulties and frequent failure is electrocoagulation. It presents no dangers for the operator who is satisfied with treatments of limited objective. Practically no pain or bleeding either accompanies or follows treatments. Electrocoagulation permits the permanent destruction of the occluding wall with a minimum risk of cicatricial synechia. The purpose of this paper is not so much to report an additional case of unilateral atresia as to direct attention to a simple, permanently effective office technic of treatment by electrocoagulation. This method should in large measure replace the often formidable and too frequently unsuccessful surgical procedures commonly in use today.

In a search of the literature on choanal obstruction, the first use of electrocoagulation which I found was in 1922 by Bourgeois and Leroux.[19] This was in a case of incomplete membranous occlusion of the right choana of a girl 21 years old. Increasingly large olive-shaped electrodes being used, the periphery of the small opening was coagulated by diathermy. Five treatments, ten days apart, gave an excellent functional result, with respiration better than on the normal side of the nose when the patient was examined eight months later. The authors distinctly specified that the technic employed (300 to 350 milliamperes) is suitable only for membranous stenosis. They stated the belief that

17. von Schroetter, L.: Ueber angeborenen knochernen Verschluss der Choanen, Monatschr. f. Ohrenh. **19**:97 (April) 1885.

18. Donnelly, J. C.: New Method of Operation for Congenital Atresia of Posterior Nares, Arch. Otolaryng. **28**:112 (July) 1938.

19. Bourgeois, H., and Leroux, L., cited by Bourgeois, H., and Poyet, G.: Traitement de certaines sténoses rebelles du nez et du pharynx par la diathermie, Rev. de laryng. **43**:883 (Nov.) 1922.

if the stenosis is mixed (osteomembranous) the destruction of only the membranous part may give a functionally excellent result without the necessity of operating on the bony part. The use of more than 400 milliamperes, they stated, makes control of the coagulation difficult.

Recent textbooks on diseases of the nose and throat, for example that by Ballenger [20] and that by Imperatori and Burman,[21] refer to this method. The latter authors expressed preference for electrocoagulation as compared with surgical intervention for membranous and osteomembranous occlusion. Chloroform is used for anesthesia.

> A fine electrode, completely insulated except at the point, is passed backward through the nose, until it touches and perforates the occluding membrane.
>
> The rubber covered palpating finger in the nasopharynx acts as a guide, while the current is turned on and the accessible membrane is destroyed.

If the mouth and throat are too small for the operator's finger, a flexible piece of metal covered with rubber or a bent piece of wood softened in hot water may be employed to protect the nasopharyngeal wall.

For infants and children, who cannot be treated under local anesthesia, this procedure undoubtedly is the method of choice in cases of membranous or osteomembranous occlusion. However, in a case of purely bony obstruction, unless the occlusion is thin, I do not believe that one treatment alone by electrocoagulation, even if extensive and severe, can give a satisfactory result. Rather, I am of the opinion that in such circumstances an opening of the obstruction made surgically and immediately followed by electrocoagulation of the cut edges, sponged as dry of blood as possible, would be more likely to remain open. I advise, in order to insure the permanence of the opening, repetition once or twice with chloroform anesthesia of the electrocoagulation of the cut edges after a three or four week interval.

Treatment of unilateral involvement can be deferred indefinitely until the best condition of the patient is attained. The program of delay is to be interrupted only if the patient's development or health is not satisfactory. Richardson [9c] expressed the opinion that it is hazardous to operate surgically before the patient is 2 years old. Syme [22] stated that an opening made before the expiration of the second year will not be permanent. Phelps [7] expressed the opinion that one may safely operate at any age and that the opening in most cases will prove permanent. In 90 per cent [5] of the cases, the occlusion, which may be as much as 12 mm.[13] thick, has been osseous, and it is usually com-

20. Ballenger, W. L.: Diseases of the Nose, Throat and Ear, revised by H. C. Ballenger, ed. 6, Philadelphia, Lea & Febiger, 1930, p. 659.

21. Imperatori, C. J., and Burman, H. J.: Diseases of the Nose and Throat, Philadelphia, J. B. Lippincott Company, 1935, p. 638.

22. Syme, cited by Ballenger.[20]

plete. This being so, one treatment by electrocoagulation with general or local anesthesia, even if extensive and severe, as was noted, cannot succeed except when the bony occlusion is thin.

REPORT OF A CASE

Miss S. R., 18 years of age, consulted me in March 1937 concerning constant obstruction of the left nostril, inability to clear the left side of the nose of secretions and annoying dripping of these secretions out of this nostril when she bent her head forward, as while eating. She was the only one in a family of 7 with this nasal defect. She was 5 feet and 2 inches (157 cm.) in height and weighed 112 pounds (51 Kg.), being 5 to 6 pounds (2.3 to 2.7 Kg.) underweight. Externally, the dorsum of the nose was deviated from the left above to the right below. The left side of the face was slightly but definitely less fully developed than the right. The left palpebral opening was smaller than the right. During an attack of measles in childhood, an aural infection had required myringotomy twice on one ear. The drum healed without leaving any perforation. The patient and her mother could not recall which ear was involved. There were no other serious illnesses. The tonsils and adenoids had been removed following the aural infection. The throat showed a small amount of chronically infected tonsillar remnants. The hard palate did not show faulty development. The teeth were in fairly good condition; the ear drums were moderately thickened and slightly retracted on both sides, but more markedly on the left. Both ears heard all tuning forks from 32 to 2048 double vibrations, but responses of the right ear were more prompt. The 128 and 256 double vibration tuning forks being used, perception in the Weber test was referred to the left. The sense of smell, tested roughly with vinegar, purified petroleum benzin, methyl salicylate and ether, was good on the right side but completely lacking on the left. The right side of the nose was clear. The left nostril was filled with a watery suspension of tenacious mucus. There was no marked irritation around the anterior nares on the left side. The nasal septum was deviated to the left side above. The mucous membrane of the left side of the nose was pale with a bluish tint. The left middle and inferior turbinates were swollen. After cleansing, no nasal respiration whatsoever through the left nostril was possible. On shrinkage of the mucous membrane with cocaine, bony underdevelopment, particularly of the left inferior turbinate, was found.

Posterior rhinoscopic examination was difficult because of gagging, even after cocainization of the pharynx. Repeated glimpses disclosed complete choanal obstruction on the left side. Far back, complete transverse, choanal, bony obstruction could readily be palpated with a probe.

Transillumination showed the left frontal sinus and antrum to be smaller than the right, but all were clear.

Roentgen examination revealed marked underdevelopment of the left frontal sinus. The left antrum was somewhat smaller than the right. All the sinuses were clear. Four unerupted and impacted third molars were present.

Treatment.—The nose first was cleansed of its accumulated discharges. The left side of the nose was anesthetized by packing with a 2 per cent solution of cocaine in physiologic solution of sodium chloride to which was added 0.3 per cent phenol. This permitted inspection and palpation with a probe to delineate the extent of the firm, bony obstruction. Because of the underdevelopment of the left turbinate bone and the greater roominess, this was readily done.

The electrode used was a rather stiff, steel cotton applicator 6 inches (15 cm.) long, the handle of which was filed down to fit the shank of the electrode holder. This was bent about 30 degrees in order to permit better illumination of the field. Thin rubber tubing was slipped over this to serve as an electric insulator. One-quarter inch (6.25 mm.) of the tip of the electrode was left bare. The electrode was applied firmly but not forcibly to the lower septal margin of the choanal obstruction and the current turned on for a moment with a foot switch just as is done in the electrocoagulation of a tonsil. A current of 2,500 milliamperes when short circuited was used. This was the equivalent of 250 to 300 milliamperes with the patient in the circuit. Five or six spots immediately surrounding the first area were similarly coagulated.

Scarcely any pain was caused by this procedure. At first, ½ grain (0.3 Gm.) of phenobarbital was given shortly before treatment, but subsequently this was found to be unnecessary. There was slight oozing occasionally but no bleeding at any time. The reaction to the treatments was never annoying enough to keep the patient from her daily work in a business office. It was not found necessary to use packing after treatment.

One week later, when the patient came for the second treatment, the accumulated nasal discharges were again removed. After cocainization, five or six spots surrounding the area first treated were coagulated.

At the third treatment, a week later, while the first area was again coagulated, the electrode easily perforated the bony obstruction. The patient was delighted to breathe through the left nostril for the first time in her life. A piece of absorbent cotton moistened with cocaine solution was pushed through this perforation and observed with a postnasal mirror. This served for orientation in placing the electrode safely while coagulating laterally and superiorly. The thickness of the bony choanal obstruction as palpated by the electrode was approximately 7 mm. Once a perforation was made, the end of the rubber tubing insulator proved a useful guide in placing the tip of the electrode around the periphery of the opening for further coagulation.

At the fourth treatment, the accumulated discharges in the left side of the nose were surprisingly reduced. The formerly pale mucous membrane had become pink, and the patient was still breathing through the small opening made on the left side. The nose was cocainized as usual, and, in addition, a small bit of absorbent cotton moistened with cocaine was again pushed through the choanal perforation. To enlarge the opening, a second electrode was made to coagulate the posterior surface of the choanal obstruction. This was similar to the first electrode except that the uncovered terminal ¼ inch (6.25 mm.) was bent at right angles to the length of the instrument. The rubber tubing insulator was slipped ¼ inch (6.25 mm.) from this right angle toward the shank of the electrode holder. This electrode was inserted through the perforation and turned toward the septal margin of the posterior surface. Firm forward pressure was employed while the current was turned on for a moment by the foot switch. The electrode was then rotated downward and similarly applied to enlarge the inferior margin of the opening. The first electrode was used on the anterior surface to coagulate points opposite these. This additional procedure caused the patient no more inconvenience than the former. The upper and particularly the lateral borders of the opening were enlarged last of all, to avoid injury to the blood vessels and nerves in the sphenopalatine and pterygopalatine canals. The choanal obstruction was thicker at its periphery than in the center. Persistent coagulation directed to the posterior margin of the septum destroyed nearly ¼ inch (6.25 mm.)

of its anterior-posterior length. It is important to stress that in order to obtain the largest possible opening consistent with safety, correct orientation in placing the electrode must be secured. This can be confirmed by inspecting with a postnasal mirror the absorbent cotton protruding through the perforated choana.

There were eight treatments in all, the last three of which were given fortnightly. The patient returned for observation at irregular intervals of several months. The nasality of her voice has decreased. Her weight has increased. There are no discharges in the nose. The sense of smell was tested in the left nostril with the same substances as before and was found to be good, although not so acute as in the right side of the nose.

It is now more than two and a half years since this work was completed. At no time, either during the course of treatments or subsequently, has there been any granulation with which to contend. The size of the choanal opening has remained permanent. The patient now breathes more freely through the left nostril than through the right.

SUMMARY

It is important again to emphasize to the obstetrician, pediatrician and general practitioner the fact that posterior congenital atresia exists and may be the cause of asphyxia in the newborn, requiring immediate relief.

In the report of the case here presented, the following points are noteworthy:

1. Failure of the left frontal sinus to develop.

2. Absence of chronic sinusitis on the left side or of any but the slightest aural involvement despite complete closure of the left side of the nose since birth.

3. Absence of thoracic deformity, arching palate or narrow nostril, which are frequently attributable to partial stenosis of the nose.

4. Conservation of the sense of smell of the left olfactory nerve after eighteen years of disuse.

5. Diminution of nasality in voice after treatment.

6. Subsequent increase in the weight and well-being of the patient.

7. Permanent and completely successful result obtained by a series of simple office treatments without loss of time to the patient, contrasting with the frequent failures and difficulties of surgical methods followed by prolonged and painful after-care.

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Case Reports

UNUSUAL CASES OF THROMBOSIS OF THE SIGMOID SINUS

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The pathogenesis, course, diagnosis and treatment of the complication of mastoiditis with which this paper deals have been known for many years. However, the tendency in the literature has been to singularize and typify the clinical picture. There is no doubt that a characteristic syndrome is encountered in the majority of cases of sinus thrombosis, but it is the purpose of this paper to stress the fact that in many of these cases the behavior is not according to the rule.

It was in 1919 that Tobey [1] wrote:

> The terms "typical" and "atypical" as applied to cases of lateral sinus thrombosis should be discarded from the literature, since they are most misleading. . . . I feel justified in making the statement that the textbook so-called "typical case" is very rare, and the otologist must be taught that each case is a problem unto itself, and that the picture is rarely complete.

Four years earlier, Day [2] reported spontaneous cure in 6 cases of unrecognized sinus thrombosis accidentally discovered during operation. From the standpoint of clinical findings, he classified cases of thrombosis of the lateral sinus into three general groups. The first group included the usual type of case, in which septic emboli are disseminated from the disintegrating thrombus in the sigmoid part of the lateral sinus. In the second group of cases the peripheral and central extremities of the thrombus become organized and remain sterile, and the center breaks down to drain through a rupture of the sinal wall. In the third the thrombus remains sterile, organizes and eventually obliterates the sinus.

Day's third group is typified by the following case:

> CASE 1.—J. M. M. was 11 years old when first seen, on Nov. 20, 1928. At the age of 6 years she had scarlet fever followed by drainage of the left ear for one month. Nothing is known of the severity of this illness, but the patient experienced transitory earache on the left side without discharge at the age of 10 years. One month prior to being seen in 1928, earache had developed on the left side; a myringotomy had been performed, and the ear had drained pus intermittently since that time. A postauricular abscess was drained shortly after the myringotomy. On examination, the left tympanic membrane appeared retracted, dull and intact, while the postaural incision was draining profusely. Roentgenograms showed diffuse

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The patients here reported on were treated in the otologic service under Dr. A. C. Furstenberg at the University of Michigan Hospital at Ann Arbor, Mich.

1. Tobey, G. L., Jr.: Lateral Sinus Thrombosis, Tr. Am. Otol. Soc. **15**:161-181, 1919.

2. Day, E. W.: Report of the Spontaneous Cure of Six Cases of Unrecognized Lateral Sinus Thrombosis Accidentally Discovered During Operation, Laryngoscope **25**:757, 1915.

clouding of the left mastoid without definite evidence of destruction of bone. Two days after admission mastoidectomy on the left side demonstrated destruction about the antrum and in the floor of the mastoid. A large perisinal abscess was discovered; the sigmoid sinus was covered with granulations and was firm on palpation, while the wall of the sinus was incised and a clean organized thrombus found. No sepsis occurred, either before or after the operation; the wound healed satisfactorily, and the patient was discharged on Jan. 13, 1929.

This patient demonstrated an asymptomatic chronic thrombosis which was sterile, and there are no means of determining its age.

More recently, some of the European otologists have been describing intermittent, progressive and chronic types of thrombosis of the sigmoid sinus. Typical of these European writings is the report by Gerlach [3] of 3 attacks which lie intermediately between the completely afebrile and the acute fulminating type. In these attacks an intermittent fever accompanied by a chill occurred but a few times and at intervals of one, two or even three weeks, with the intervals completely symptom free. Such attacks may extend over three or four months, he said.

The next case to be reported falls into the group described by Gerlach [3] and first stimulated my interest in the unusual cases of sinus thrombosis.

CASE 2.—F. L., aged 58, was first seen on Feb. 28, 1935. Five weeks earlier a cold in the head had developed, with earache on the right side. Myringotomy had been performed, and the ear had drained steadily, although there had been no pain, headache, fever or vertigo. The right canal was found to contain thick mucopus; the tympanic membrane was dull and injected and had a central perforation through which some granulations projected. The region of the mastoid was tender to pressure over the antrum and the tip. Roentgenograms showed acute mastoiditis on the right side, with destruction of intercellular walls in the postsigmoid area. When the patient was admitted to the hospital the following day, the temperature, pulse, respirations and blood were normal.

On the day following admission (March 2) mastoidectomy was performed on the right side and a pneumatized mastoid with coalescent mastoiditis found. The dura and the sigmoid sinus were exposed and appeared normal. The postoperative course was entirely uneventful, and the patient was discharged on the seventh postoperative day with a dry middle ear, a small perforation in the tympanic membrane and the postaural wound almost healed.

Five days after being discharged, he experienced a chill and a rise of temperature to 103 F., with pain appearing in the right parietal area. Three days later a second chill occurred, with a rise of temperature to 104 F., and he was readmitted to the hospital. Both tympanic membranes were intact and nearly normal, although the postaural wound was not entirely healed. The white blood cell count was 14,300, and a blood culture showed Pneumococcus type III. The temperature on admission was 103.5 F., but between March 18 and 27 it rose but once to 102 F., on March 22. Roentgenograms of the mastoid did not show evidence of petrositis or any mastoid cells remaining. Although the patient complained of frontoparietal pain on the right for a few days, this subsided spontaneously. No growth developed in a blood culture taken on March 21, and the patient insisted on leaving the hospital on March 27.

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3. Gerlach, H.: Chronische Sinusthrombosen, Ztschr. f. Hals-, Nasen- u. Ohrenh. **39**:262-280, 1936.

He was returned in a semicoma on April 3, and a history of chills and fever on the preceding four days was obtained. His temperature was normal on the day of admission, and no growth developed in a blood culture taken on the day following admission. The usual agglutination reactions were negative, and the white blood cell count was 14,300. The chief complaint now was temporoparietal pain on the right side, accompanied by sharp elevations of temperature to 103.5 and 104 F. on April 7 and 9. The pneumococcus grew in a blood culture taken on the ninth, but one taken on the tenth was sterile, although the condition was poor. From April 11 to 25, the temperature was essentially normal, and the patient improved greatly. There was one more rise in temperature, on April 22, followed by gradual improvement. On May 6 the temperature, pulse rate and respiratory rate rose to 108 F., 150, and 40, respectively, and the patient went into a coma, from which he did not recover. Fulminating purulent meningitis, with Pneumococcus type III cultured from both blood and spinal fluid, was found. Continuous drainage of the spinal fluid was started, and the patient died on May 8, two months and four days after the complete mastoidectomy.

Ophthalmologic, medical and neurologic examinations were made frequently and gave negative results until the onset of the meningitis. The patient died on the sixty-seventh postoperative day. During that interval five blood cultures were taken, an attempt being made to get blood for culture near the peak of the intermittent fever, with a positive culture twice and no growth three times. There were eleven known sharp rises of temperature, and the remainder of the time the temperature was essentially normal. This case has not been duplicated in a busy otologic service during the past four years.

Unsuspected sinus thrombosis has been found at operation with both acute and chronic mastoiditis, and examples of this finding are seen in the following 2 reports.

Case 3.—A. F., aged 10 years, had an infection of the upper part of the respiratory tract, with malaise and anorexia as the most striking symptoms but with no aural complaints, early in March 1932. She was first seen on April 26, when the right tympanic membrane was dull and thick. The following day myringotomy was performed, and the middle ear was found to be dry. The white blood cell count was 17,250. A subperiosteal abscess developed suddenly on the right side six days later, and complete mastoidectomy on the right side on May 3 demonstrated extensive necrosis of the bone. A perforation was found in the parietal wall of the sigmoid sinus and considerable pus in the softened thrombus, obliterating the lumen. Free bleeding was obtained from the end nearest the torcular Herophili but not from the bulb. Culture of the pus demonstrated hemolytic streptococci. Convalescence was slow but progressive, and at no time was there any significant elevation of temperature. The patient was discharged three months after operation with both the tympanic membrane and the postauricular wound healed.

Case 4.—J. N., 42 years old, had suffered otorrhea on the left side for twenty years. The discharge ceased and pain developed over the left side of the head on Sept. 16, 1932. He was seen one week later. A foul discharge was present in the left canal, and a large polyp occluded the perforation in the tympanic membrane. Marked tenderness to pressure was observed over the lower half of the mastoid. The patient did not have chills. The temperature on admission was 104.5 F., and within a few hours he became irrational. Roentgenograms

showed contracted sclerotic mastoid processes bilaterally, and radical mastoidectomy was performed on the left side on September 24. The cellular development was limited to the periantral region, and a large perisinal abscess was found, while the parietal wall was necrotic and the contained thrombus was firm and well organized. The patient continued a septic course, and three and four days after operation the left and right eyes became proptosed, death occurring six days after the radical mastoidectomy. Postmortem examination revealed bilateral thrombosis of the cavernous and sigmoid sinuses, acute purulent leptomeningitis and hematogenous confluent lobular pneumonia with abscesses and early gangrene.

This patient had well organized chronic sinus thrombosis eight days after the first symptom of the acute exacerbation of the chronic mastoiditis and died of acute leptomeningitis six days later.

Cases 3 and 4 probably fall into Day's second group, in which the ends of the thrombus are sterile and organized, so that embolism does not occur, but the center drains itself into the mastoid by rupturing the parietal wall of the sigmoid sinus. Here again, one cannot begin to postulate the age of either thrombus.

CASE 5.—G. F., aged 11 years, was first seen on April 20, 1933, with a history of intermittent bilateral otorrhea present for two years. On the first examination, the perforation in the left tympanic membrane was dry; there was some purulent discharge on the right, and a polyp was removed to improve the drainage. The right ear continued to drain, and on July 24 the boy had pain in the ear, with a high temperature and pain over the right side of the head developing in twenty-four hours. On July 29 he had a chill, and projectile vomiting and stiffness of the neck developed. He was admitted to the hospital on July 31, at which time the right canal contained some foul pus, the tympanic membrane was pink and retracted, with a small central perforation, and there was tenderness to pressure over the right internal jugular vein. Ophthalmologic and neurologic examinations gave negative results, and a blood culture did not show any growth.

Radical mastoidectomy was performed on the right side on August 2. The sigmoid sinus was flat and dull. Before the operation on the sinus, the neck was opened; the internal jugular vein was found to be thrombosed to its junction with the subclavian, and a ligature was applied at this junction. The lateral sinus was then opened and found to be filled with an infected old clot, while free bleeding was not obtained from either end. Culture of the pus inside the sinus demonstrated Bacillus coli. The condition of the patient was satisfactory on the first postoperative day, but on the second the temperature rose to 104 F. and the respiratory rate to 40, with physical findings of pleural effusion and pneumonia, and B. coli was cultured from the sputum. Empyema and pulmonary abscess developed, while closed and open drainage of the empyema occurred, and eventually the lower lobe of the right lung was excised for the abscess. The mastoid cavity healed satisfactorily, and the patient was last seen on March 12, 1936, with the cavity of the radical mastoidectomy in good condition, healed wounds from the mastoidectomy and the operation on the neck and a healed lobectomy scar.

Here the chronic sinus thrombosis was demonstrated nine days after the onset of the acute exacerbation, and the thrombosis was of unknown age. An unusual organism, B. coli, was involved, and the patient ran the gamut of thoracic surgical treatment before recovery.

In the next 2 cases to be described, actual cholesteatoma was found in the lumen of the sigmoid sinus.

CASE 6.—In R. P., aged 23, otorrhea developed on the left side in 1925, which continued until he first came to the hospital in 1933. Mastoidectomy had been done in 1931 without relieving the otorrhea, and on July 4, 1933, severe pain developed in the left ear, with nausea and vomiting two days later and the next day a severe chill. When the patient was admitted to the hospital, on July 7, the temperature was 106 F., with a foul discharge in the left canal, marked drooping of the posterior superior quadrant of the external auditory canal and marked tenderness to pressure over the mastoid. A central type of palsy of the left facial nerve was present, although the disks were not choked and the remainder of the neurologic examination gave negative results, while the leukocyte count was 17,250.

On July 8 complete mastoidectomy was performed on the left, and extensive excavation of the mastoid by the cholesteatoma was encountered. The parietal wall of the sinus was eroded, and the lumen contained cholesteatoma and an old organized thrombus, although free bleeding was obtained from the end nearest the torcular Herophili. The patient died the following day. Postmortem examination was not permitted.

CASE 7.—G. P. was 38 years old when first seen, on Nov. 5, 1931. He had suffered from intermittent otorrhea on the left side since childhood, and at this time fever and chills had been present for three days. On admission the temperature was 106.2 F., the left canal was filled with foul pus and there was a furuncle in the canal which shut off all view of the tympanic membrane. Neurologic examination gave negative results, and radical mastoidectomy was performed on the day of admission by the late R. B. Canfield. The middle ear and antrum were filled with cholesteatoma, although the sigmoid sinus did not appear particularly abnormal. A septic course continued, and a week later the patient was again operated on, when the jugular vein was found to be collapsed above the facial vein and was ligated. The sigmoid sinus was opened and found filled with cholesteatoma, and free bleeding was obtained posteriorly. The cerebellar dura was bulging and was incised, plastic exudate on the leptomeninges being encountered. On November 24 the patient became comatose; proptosis of the left eye developed, and thrombosis of the cavernous sinus was diagnosed, his death occurring on the following day.

Throughout his stay in the hospital the patient was septic, but the white blood cell count was never above 15,800 on seven examinations, and three blood cultures were negative. A streptococcus was cultured from the mastoid and the lumen of the sigmoid sinus.

These 2 patients must have had their sinus thrombosis for months or years to account for the cholesteatoma present in such large amounts in the lumen of the sigmoid sinus, although neither of them showed any signs or symptoms of serious complications of the mastoiditis until a comparatively few days before death.

CASE 8.—This last and interesting case was that of a private patient of Dr. A. C. Furstenberg, who has given me permission to include it among these unusual cases of thrombosis of the sigmoid sinus. J. G., aged 10 years, is a physician's son. A preauricular abscess was drained on Jan. 1, 1938, and a complete mastoidectomy on the right side followed on January 5. On January 13 complete mastoidectory was performed on the left side, and the right sigmoid sinus was exposed; it appeared to be normal but was needled and blood obtained. The boy had a convulsion on the next day, but there had not been any chills. He had a mild daily elevation of temperature; his general condition did not improve, and it was at this time that the boy was brought to Ann Arbor and placed under Dr. Furstenberg's care.

Ophthalmologic and neurologic examinations on the day of admission did not yield new information, and a roentgenogram of the chest was normal. The white blood cell count ranged about 16,000 daily, and there was little rise in temperature. The wounds were in satisfactory condition, and the boy seemed to be improving.

On February 10 two clonic convulsions occurred on the left side, followed by left hemiparesis. Left temporal homonymous hemianopia and left astereognosis were discovered, and the next day the neurosurgical consultant, Dr. Max M. Peet, trephined the skull and needled the right temporal lobe but did not find an abscess. A ventriculogram was made, showing only moderate dilatation of all ventricles. The temperature went to 104 F. on the tenth and eleventh and then decreased once more. Forty-eight hours later the mastoidectomy wound on the right side was opened, and free pus was found in the sigmoid sinus. Bleeding was obtained posteriorly but not from the bulb, and the internal jugular vein was ligated. Between February 10 and 23 the patient received 38 Gm. of sulfanilamide by the oral and the intravenous route and showed progressive improvement, being discharged without neurologic signs on March 6.

This patient showed definite localizing signs of an abscess of the right temporosphenoid lobe, yet aspiration of the brain failed to demonstrate this condition. Thrombosis of the sigmoid sinus, in the absence of chills, repeated high temperature or a positive blood culture, was found, while the neurologic findings subsided and the patient recovered after obliteration of the sigmoid sinus and ligation of the internal jugular vein. This is the first case in Dr. Furstenberg's experience in which definite localizing signs of abscess of the brain have been produced by thrombosis of the sigmoid sinus.

These experiences are all far from the usual picture of thrombosis of the sigmoid sinus, showing that the thrombosis may be entirely asymptomatic and found only accidentally, at mastoidectomy. The thrombosis may seal itself off at both ends, precluding embolic phenomena and drain itself by destroying the parietal wall of the sigmoid sinus; cholesteatoma may be found in the lumen of the lateral sinus. The old dictum that meningitis, abscess of the brain and thrombosis of the sigmoid sinus can each simulate the others is recalled by the last case, in which thrombosis of the sigmoid sinus apparently produced localizing signs of abscess of the temporosphenoid lobe.

607 Medico-Dental Building.

PRIMARY MIXED CELL MYELOMA OF THE MOUTH INVOLVING THE ANTRUM

ROBERT F. ROH, M.D., NEWARK, N. J.

This case is reported because of the unusual pathologic picture in a primary tumor of the superior maxilla. Other cases of plasma cell tumors about the head and neck without skeletal involvement have been reported.[1] So far as I am aware there are but few cases of such a tumor originating about the alveolar process.

Myelomas are considered most commonly to be tumors of the bone marrow which show multicentric foci of origin and produce certain characteristic roentgenologic changes in the bone involved. In addition, certain findings in the blood and urine are, as a rule, more or less commonly associated with the disease.

Histologically the new growths may vary in appearance from case to case and even from point to point within the same tumor. Study of numerous sections, however, almost invariably reveals collections of plasma-like cells with eccentric nuclei, which are the most significant and pertinent factor in making a microscopic diagnosis.

Proceeding from this characteristic picture one finds scattered reports in medical literature which deal with localized growths which have a microscopic picture similar to that of multiple myeloma but whose somatic behavior is apparently different. These tumors occasionally appear to arise from the soft tissues, remain localized and act in a relatively benign fashion.[2] On the other hand, metastases may occur, and the course of the growth may be that of a typical lymphosarcoma of the more malignant variety.

The following case is one in which a myeloma arose within the maxilla and involved the antrum and mouth and after its removal a new focal point of origin of tumor tissue was found in the mandible.

REPORT OF A CASE

Mrs. M. C., aged 71, was admitted to the hospital on Feb. 10, 1939. Four days previously her physician had been called because of a small swelling on the upper right alveolar border. The patient described the swelling as a "gum boil" and

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Read at a clinical meeting of the Academy of Medicine of Northern New Jersey, Newark, N. J., Oct. 2, 1939.

1. Claiborn, L. N., and Ferris, H. W.: Plasma Cell Tumors of the Nasal and Nasopharyngeal Mucosa, Arch. Surg. **23**:477 (Sept.) 1931. Jackson, H.; Parker, F., and Bethea, J. M.: Studies of the Diseases of Lymphoid and Myeloid Tissue: II. Plasmacytomata and Their Relation to Multiple Myelomata, Am. J. M. Sc. **181**:169, 1931. New, G. B., and Harper, F. R.: Plasma Cell Myeloma of the Pharynx and Cervical Region Without Skeletal Involvement, Arch. Otolaryng. **16**:50 (July) 1932. Pollock, F. J.: Plasmacytoma of the Nose and Nasopharynx, ibid. **19**:311 (March) 1934. Cooper, K. G.: Plasmocytoma and Rhabdomyoma of the Paranasal Sinuses, ibid. **20**:329 (Sept.) 1934. Blumenfeld, L.: Plasma Cell Tumors of the Nose and Nasopharynx, Ann. Otol., Rhin. & Laryng. **45**:436, 1936.

2. Ewing, J.: Neoplastic Diseases, ed. 3, Philadelphia, W. B. Saunders Company, 1928, p. 420.

said it had been present for about two months. Because the swelling looked and felt like an abscess the doctor incised it and immediately was greeted with a profuse hemorrhage, which he stopped with great difficulty and then only after the use of packing. He said the packing seemed to go into a deep cavity. On three successive days the bleeding returned. The patient was weak and anemic from loss of blood and was brought to the hospital for better control of any future hemorrhage.

On February 16 a roentgen examination of the maxillary bones (fig. 1) revealed evidence of a destructive lesion involving the inferior border of the right maxilla and a soft tissue tumor in that region. Biopsy was advised. On February 21 a superficial specimen was taken for biopsy, and the tissue from this specimen was diagnosed as chronic suppurative inflammatory tissue. At that time what was thought to be a gastrointestinal disturbance or one of the gallbladder developed, and it was impossible for the patient to retain food. Dextrose was given intra-

Fig. 1.—Plain roentgenogram of the antrums.

venously, and for two weeks the general physical condition demanded more attention than the tumor in the mouth. On March 2 I first saw the patient. She was obese but looked rather exhausted from her periods of vomiting and loss of blood. She had no pain about the face, the nose was free of mucus, with normal turbinates and lateral nasal walls; there was no nasal or postnasal discharge. No cervical glands were palpable. All teeth had been removed one and a half years before. The mass in the mouth appeared nearly as large as seen in figure 2; it was soft and smooth, with an ulcerated area at the site of the removal of the specimen for biopsy. The growth seemed most probably to be malignant, and after a Wassermann test was made, which was negative, its radical removal, including resection of the superior maxilla, was suggested. Both the attending physician and the patient felt the procedure was rather formidable and were inclined to believe that she would not survive such treatment. I certainly was not so sure that she would and so did not press the matter. Transfusions were given on March 6 and March 15, and after further deliberation it was mutually agreed to proceed with the operation. On March 22 Dr. Henry Orton kindly consented to see the patient and made the suggestion that iodized poppyseed oil should be instilled to further the study of the involvement within the antrum. Figure 3 shows the

result of this examination, made on March 24, outlining a mass which nearly filled the antrum. The iodized poppyseed oil was instilled through the natural ostium. Considering the extent and low location of the tumor within the antrum I believe that injection through the usual route, that is, the inferior meatal,

Fig. 2.—Tumor as it extended into the mouth.

would not have given such good results and probably would have precipitated profuse bleeding because of puncture into the tumor.

Preliminary ligation of the right external carotid artery was done on March 25, which the patient withstood remarkably well under cyclopropane anesthesia. Three days later, with the patient under anesthesia induced by nitrogen monoxide, oxygen and ether, the right superior maxilla was partially resected and the

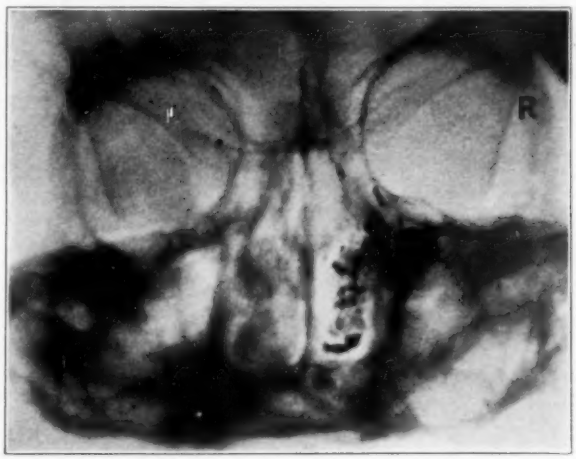

Fig. 3.—Roentgenogram of the antrums after the injection of iodized poppyseed oil into the right antrum.

tumor totally removed. The tumor appeared to emanate from the right upper alveolar border and extended into the mouth about 2.5 cm. The upward expansion almost entirely filled the antrum, within which it was soft and smooth, with a bluish membrane that looked like a sac. This was easily dislocated from the antral walls and removed through the opening previously made in the floor of the antrum.

The histologic examination of the tumor (fig. 4) showed a cellular new growth with a minimal supporting stroma. The component cells varied in appearance in different parts of the growth. In some areas they were small with deeply staining, granular and eccentric nuclei resembling plasma cells. In other areas they were larger with clear cytoplasm and vesicular nuclei and were suggestive of a granulocytic origin. In the latter areas were present also large cells with multilobed nuclei and acidophil nucleoli.

The tumor was vascular and showed numerous areas of necrosis and interstitial hemorrhage. Sections stained with hematoxylin and with eosin were submitted to Dr. F. W. Stewart, of Memorial Hospital, New York, and portions of the specimen were sent to Lt. Col. J. E. Ash, of the United States Army Medical Corps. Both these authorities agreed that the neoplasm was a myeloma.

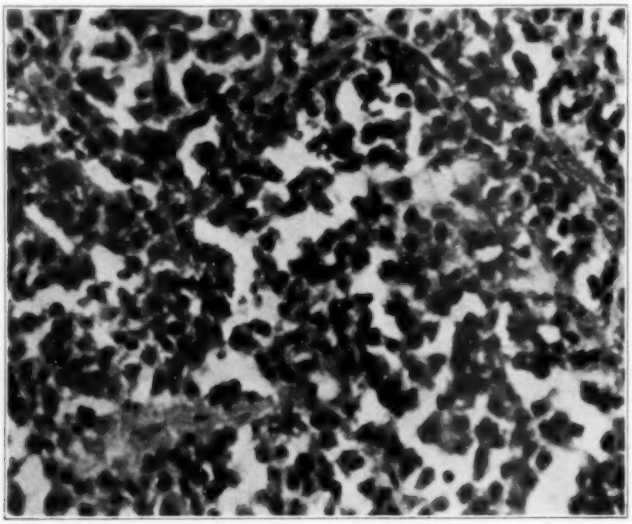

Fig. 4.—Photomicrograph of a section from the right maxilla showing numerous characteristic plasma cells, with eccentric hyperchromatic nuclei (× 600).

Consultations from roentgenologic and radiologic standpoints were held with Dr. W. J. Marquis and Dr. M. J. Friedman, and a program of further examinations and treatments was worked out.

A sternal puncture was performed on April 13, and examination of the bone marrow (fig. 5) revealed erythropoietic hyperplasia without evidence of atypical cell proliferation. On April 18 roentgenologic studies were made of the skull, spine, sternum, ribs and pelvis. Evidence of lesions resembling multiple myeloma was not found.

Examination of the urine showed a specific gravity ranging from 1.009 to 1.018. All the specimens contained albumin (2 plus) and at no time could Bence Jones protein be detected. Numerous pus cells and occasional hyaline casts and red blood cells were present.

The blood count showed a hemoglobin content (Newcomer) of 43 per cent, and the erythrocytes numbered 3,000,000 per cubic millimeter. There was no

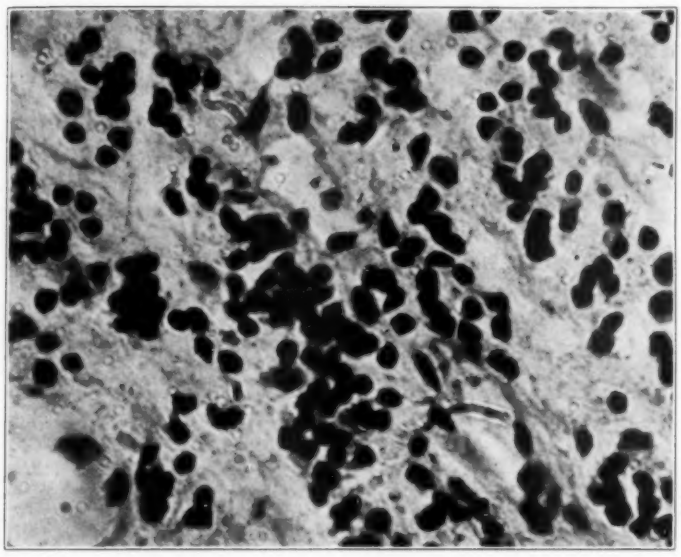

Fig. 5.—Bone marrow—no atypical cells evident (high power).

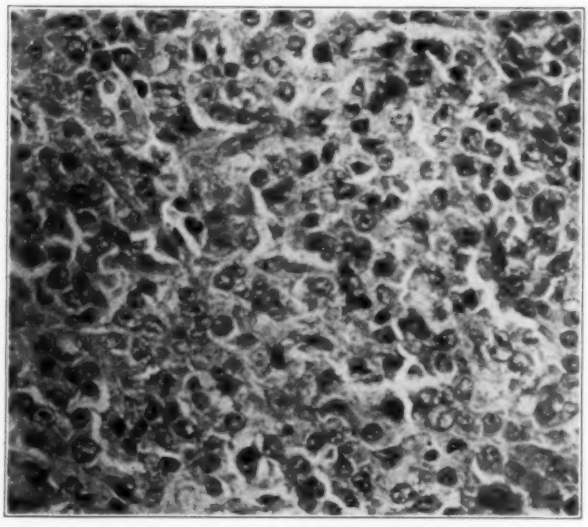

Fig. 6.—Photomicrograph of a section from the left side of the mandible showing large cells with vesicular nuclei; these resemble reticulum cells; moderate numbers of mitotic figures are evident (× 600).

evidence of spontaneous isoagglutination of the erythrocytes. The Wassermann and Kahn tests on the blood were negative throughout. The urea nitrogen content of the blood (Karr) was 112 mg. per hundred cubic centimeters. The total protein content of the blood was 6.24 per cent, albumin comprising 2.41 per cent, fibrinogen 0.65 per cent and globulin 3.18 per cent. Significant among the foregoing observations were the marked anemia, the marked retention of nitrogen and the reversal of the albumin-globulin ratio.

After another blood transfusion the patient began to improve generally; the maxilla was healing nicely, with no signs of recurrence visible. She was eating quite well and sitting up in a chair and asked to go home. On April 20 I was amazed to notice a small tumor on the lower left jaw, which I removed by diathermy two days later. Microscopic examination (fig. 6) showed the same type of plasma cell tumor.

The patient then became restless and demanded to go home. Two weeks later her physician reported that she had died suddenly. Unfortunately permission for autopsy was not granted.

The clinical picture, as in this patient, might easily be mistaken for that of a simple abscess of the gum or of an epulis (multinucleated cell tumor of the gum). Sachs and Garbe [3] described the latter condition, which is readily diagnosed by microscopic examination of the tumor.

SUMMARY

1. A case of myeloma originating about the alveolar process is reported.

2. It is suggested that instillations of iodized poppyseed oil into the antrum are best made through the natural ostium or by the Proetz displacement method, especially when a tumor involving the lower half of the antrum is suspected.

3. Early use of radium or roentgen therapy after radical removal of the tumor is advised.

The photomicrographs were copied from some furnished by the United States Army Medical Museum.

Dr. Edward Fendrick, of the East Orange General Hospital, helped with the pathologic description and the comments on the illustrations.

3. Sachs, W., and Garbe, W.: Multinucleated (Giant) Cell Tumor of the Gum (Epulis), Arch. Dermat. & Syph. **38**:603 (Oct.) 1938.

PRIMARY CARCINOMA OF THE TRACHEA

ISIDORE MILLER, M.D., NEW YORK

Primary carcinoma of the trachea is a rare lesion; only 147 cases had been reported in the literature up to June 1936. This lesion forms 34 per cent of the primary tracheal tumors reported. The incidence of primary tracheal carcinoma in series of autopsies varies from zero to 1.4 per cent. The latter percentage was reported by Fraenkel.[1] Many hospitals have not noted a single lesion of this type in thousands of autopsies. Culp[2] reported that a personal survey yielded no primary carcinoma of the trachea observed in 15,000 autopsies at the Johns Hopkins Hospital; none in 7,000 autopsies at the Baltimore City Hospitals and none in 3,900 autopsies at the New Haven Hospital. He reported 2 cases; in 1 the lesion was the only primary tracheal carcinoma seen in 9,000 autopsies at the Pathologic Institute of McGill University, and in the other it was the only one noted in 12,700 autopsies at the Montreal General Hospital.

Karsner[3] stated that tumors of the trachea are uncommon; of the malignant tumors, which also are extremely rare, carcinoma is the most frequent, appearing usually as squamous epithelioma, probably originating in islands of squamous epithelium either of congenital origin or as the result of metaplasia following injury. Secondary tumors sometimes occur but are decidedly unusual. Figi,[4] on the other hand, found that adenocarcinoma is most common.

REPORT OF A CASE

A 65 year old white man was admitted to the Farm Colony Hospital on Sept. 2, 1937. He had been in another hospital from August 6 to September 2 with the diagnosis of fractured right seventh rib and traumatic hemothorax. A roentgenogram of the chest showed emphysema and fracture of the right seventh rib. The chest was strapped, and when the symptoms cleared up the patient was transferred to the Farm Colony for further convalescence. On his admission to this institution his chief complaints were dryness and tickling of the throat. His past history included a history of a chancre forty years previously, which had never been treated, and several attacks of gonorrhea. He had been attending an outpatient clinic because of arthritis of the knees. His physical examination yielded essentially

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From the New York City Farm Colony and the Department of Pathology, Sea View Hospital, Dr. Oscar Auerbach, pathologist.

1. Fraenkel, E.: Ueber Luftröhrenkrebs, Deutsches Arch. f. klin. Med. **135**: 184 (Feb.) 1921.

2. Culp, O. S.: Primary Carcinoma of the Trachea, J. Thoracic Surg. **7**:471 (June) 1938.

3. Karsner, H. T.: Human Pathology, Philadelphia, J. B. Lippincott Company, 1926.

4. Figi, F. A.: Primary Carcinoma of Trachea, Arch. Otolaryng. **12**:446 (Oct.) 1930.

negative observations except that the lungs showed evidence of emphysema. Because of the presence of hoarseness, a laryngeal examination was made on September 21. Paralysis of the right vocal cord with absence of abduction was found. Syphilis was considered a possible etiologic agent because of the patient's history, but the Wassermann test was negative. A roentgenographic examination of the chest on October 26 showed generalized opacity involving the apex of the right lung and the infraclavicular region and an area of opacity in the apex of the left lung. The generalized opacity seemed to fill the entire superior aperture of the chest (fig. 1 *A*). The trachea was displaced to the left. The possible diagnoses were considered to be (1) enlargement of the thyroid, (2) a bronchogenic neoplasm in the upper lobe of the lung, (3) a tuberculous end stage caseous pneumonic lesion and (4) aneurysm of the aorta. Fluoroscopic examination showed the mass to be distinct from the aorta. A roentgenogram of the chest one month later disclosed a metastatic nodule in the lower lobe of the right lung (fig. 1 *B*).

Bronchoscopic and esophagoscopic examination were done on December 28 by Dr. A. Seligman. At a point in the trachea, 20 cm. from the tooth line, a bleeding

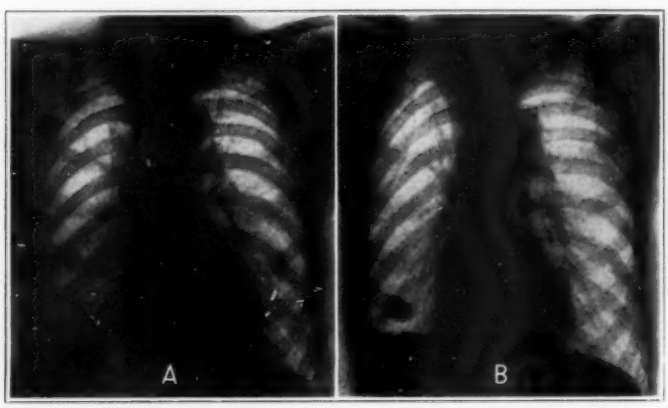

Fig. 1.—*A*, roentgenogram taken on Oct. 26, 1937, showing an opacity filling the entire superior aperture of the chest and an area of opacity in the apex of the left lung. *B*, roentgenogram taken on Nov. 17, 1937, showing a metastatic nodule in the lower lobe of the right lung.

mass was found, from which a specimen was taken for biopsy. The posterior wall of the trachea bulged. The esophagus showed some compression. The biopsy was performed by Dr. Auerbach, who reported that "Microscopic examination reveals large sheets of epithelial cells. The nuclei are hyperchromatic, large and oval or round. Numerous mitotic figures are present. The diagnosis is squamous cell carcinoma."

The patient felt better for two days after the bronchoscopic examination. He was elated that his hoarseness had decreased. But this was only temporary. Dyspnea and cyanosis increased, and the patient died on Feb. 13, 1938.

The necropsy was performed by Drs. Auerbach and M. Herman. On opening the thoracic cage, a large mass was noted extending up from the bronchial bifurcation to the fifth cervical vertebra on the right side of the vertebral column. This mass measured 15 cm. in its vertical direction and 9 cm. in its greatest transverse direction. It was composed of matted firm lymph nodes, which on section revealed

a whitish aspect. In the right angle was a fluctuant mass measuring 6 cm. in its vertical direction, which on section exuded about 2 ounces (60 cc.) of purulent material and large white particles. A great deal of coal pigment also was present. In the upper posterior aspect there was another fluctuant mass, which measured 6 cm. in its vertical direction. On section this revealed a small amount of purulent material and a pinkish substance which could be teased out into strands. The larger arterial vessels traversing this mass were markedly constricted, and the lumens were appreciably narrowed. The entire mass was firmly adherent to the trachea. Six centimeters from the inception of the esophagus in the pharynx were several firm, whitish masses measuring up to 2 cm., which surrounded that organ, causing some narrowing of the lumen. These masses on section presented a whitish, glairy aspect.

Four centimeters below the true vocal cords the trachea revealed a fungating mass, which extended down to the bifurcation, approximately 9 cm. This fungating mass had a cauliflower appearance and was pinkish. It was firmly adherent to the underlying mucosa and was soft. The distribution was principally on the anterior and right lateral surfaces.

The upper lobe of the left lung presented posteriorly beneath the thickened pleura at the apex an area 2 cm. in the apicobasal direction and 1.5 cm. in the mediolateral direction. This was flat topped and firm to the touch. This focus was not sharply demarcated from the surrounding lung tissue. In the anteromedial aspect, 8 cm. from the apex, just below the visceral pleura, was a firm, rounded nodule measuring 1 cm. On being sectioned this was flat topped, presented a whitish brown homogeneous appearance and was sharply demarcated from the surrounding lung tissue. In the lower lobe of the left lung, 8.5 cm. from the apex and just below the lateral pleura, was a nodule 1.5 cm. in its apicobasal direction and 1 cm. in its mediolateral direction. This was firm, flat topped and whitish pink and was sharply demarcated from the surrounding lung tissue. In the lower lobe of the right lung, anteriorly, was a large nodule 2 cm. in length and 3 cm. in width. On being cut it presented a whitish brown aspect and was sharply demarcated from the surrounding lung tissue (figs. 2 and 3).

In the upper third of the esophagus there was an ulcerated area, 3 cm. in circumference. The surrounding walls were elevated and overhanging. The base had a white surface and was clean. The entire area felt indurated.

The pathologic observations were as follows: carcinoma of the trachea with metastases to the lower lobe of the right and the upper and lower lobes of the left lung; localized fibrous pericarditis; dilatation of the left ventricle; calcification of the aortic valve; atheromatosis of the coronary vessels; atheromatosis, calcification and ulceration of the aorta; dilatation of the ascending aorta; calcification of the capsule of the spleen; perisplenitis; congestion of the liver, spleen and kidneys; retention cyst of the kidney; bilateral granular kidney; diverticulosis of the large intestine; ulceration of the esophagus; healed old fracture of a rib; mediastinal tumor—(1) suppurative paratracheal lymphadenitis and (2) metastatic lymph nodes (carcinoma); benign hypertrophy and adenoma of the prostate.

Histologic examination of the trachea was reported on as follows: In one area the epithelial lining is columnar. It is interrupted, and in the region involved are dense nests of epithelial cells arranged in sheets. These sheets of epithelial cells extend into the periglandular region, encircle the cartilage and extend into the adventitia. In some regions these nests of epithelial cells are present beneath the intact epithelium. The nuclei of the cells are oval or round and are of various size. Most of the cells, however, are large. Mitotic figures are present also. Most of the nuclei are vesicular; some are hyperchromatic.

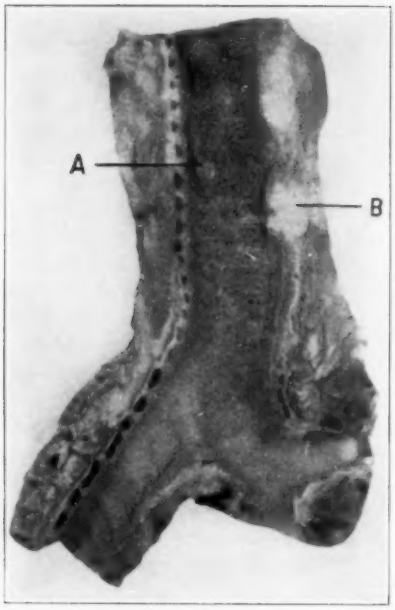

Fig. 2.—A section of the trachea and the main bronchi. The fungous carcinoma (*A*) is present along the entire course of the trachea. There is extensive infiltration of the carcinoma through the wall of the trachea (*B*).

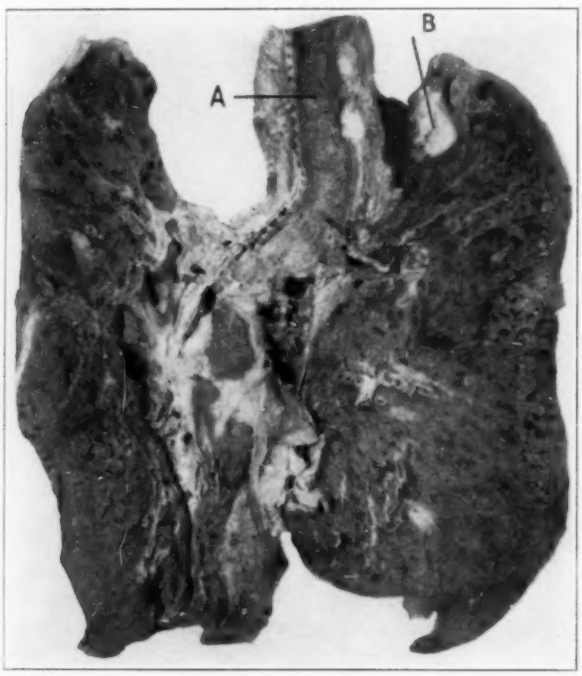

Fig. 3.—Coronal section of the lungs. The carcinoma of the trachea in figure 2 is seen in this view (*A*). Carcinoma has also extended into the upper portion of the upper lobe of the left lung (*B*).

COMMENT

Primary carcinoma of the trachea is rare; however, the literature on the subject is fairly complete. Because of the rarity of the lesion, new cases are usually reported. The literature has been frequently reviewed and brought up to date.

The condition has been reported in every decade from the second to the ninth, with the largest incidence in the fifth and sixth decades. Males have predominated in the reported cases (6:4). Metastases were usually to the esophagus, the mediastinal, peribronchial and cervical lymph glands and the lungs. Tickling in the throat and hoarseness were common initial symptoms, but cough, hemoptysis, dyspnea and wheezing respiration were frequently present as the main symptoms. The prognosis is poor. The diagnosis is still seldom made ante mortem, but the more frequent use of laryngoscopic and bronchoscopic examinations will be of inestimable aid in the quicker recognition of tracheal tumors.

SUMMARY AND CONCLUSIONS

A study of a case of primary carcinoma of the trachea in a 65 year old white man has been presented. A tickling sensation in the throat and hoarseness were the initial symptoms. Bronchoscopic examination was the most important method of diagnosis. Laryngoscopic and roentgenologic examinations also were an aid. The patient died six months after the symptoms first appeared. The more frequent use of bronchoscopic examination will enable more diagnoses of this disorder to be made ante mortem.

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Clinical Notes; New Instruments and Technics

A TUNING FORK AUDIOMETER

AARON ROTH, M.D., BROOKLYN

In 1932 I suggested a graphic method of tuning fork audiometry.[1] The method was tedious and not based on a standardized scale of normal hearing. It was abandoned.

In 1934 I devised the acoustimeter. This consisted of a series of calibrated tuning forks mounted on a revolving turret. The forks were struck by a swinging hammer allowed to drop from a constant level. A stop watch connected with the hammer indicated the duration of audibility (from the time the fork was struck to the loss of audibility). The number of seconds of audibility was marked in a corresponding place on the chart. This at once showed the loss of hearing in decibels.

In connection with this instrument the principles of modern audiometric arithmetic were for the first time applied to precision tests of acuity of hearing with tuning forks as the source of sound.

However, the instrument was cumbersome, expensive and difficult to standardize.[2]

NEW PRECISION FORKS

I have now made a series of calibrated forks. A detachable hammer is provided. Together these constitute a practical, accurate, portable and inexpensive audiometer. The forks are light and are not mounted but held suspended on the examiner's fingers. There are no extraneous and confusing sounds. The method and chart are based on the standard scale of threshold of hearing to threshold of feeling used with electrical audiometers.

The application of the decibel (unit of intensity of sound) to tuning fork values is self explanatory on the chart.

It was necessary to make forks that could produce intensities loud enough to reach the upper level of the range of hearing (that is, the threshold of feeling).

In connection with the tuning forks there are several entirely new features which I have not published before.

Through the stem of the fork is a cross pin used as a rest on the thumb and finger (fig. 2). This makes the fork a freely suspended vibrating source of sound. By this method of suspending the fork the absorption of the vibrations into the hand is minimal and constant. This method of using the forks is an important factor in assuring constancy of the source of sound.

A significant new principle is seen in the cup-shaped sound collector which I have fashioned at the end of the stem. This conveys the sound clearly and

From the Department of Otolaryngology, Beth El Hospital.

1. Roth, A.: A Graphic Method and Chart for Hearing Test with Tuning Forks, Arch. Otolaryng. **15**:834 (June) 1932.

2. Roth, A.: The Acoustimeter: A Device of Tuning Forks with a Graphic System for Charting Acuity of Hearing, Arch. Otolaryng. **20**:571 (Oct.) 1934.

Fig. 1.—New precision fork with hammer in place.

Fig. 2.—Fork with cross pin resting on the thumb and finger.

completely to the ear (fig. 3). By these features it is obvious how one attains constant intensities of the sound produced by a hammer dropped from a constant level.

Fig. 3.—Sound collector in contact with the ear.

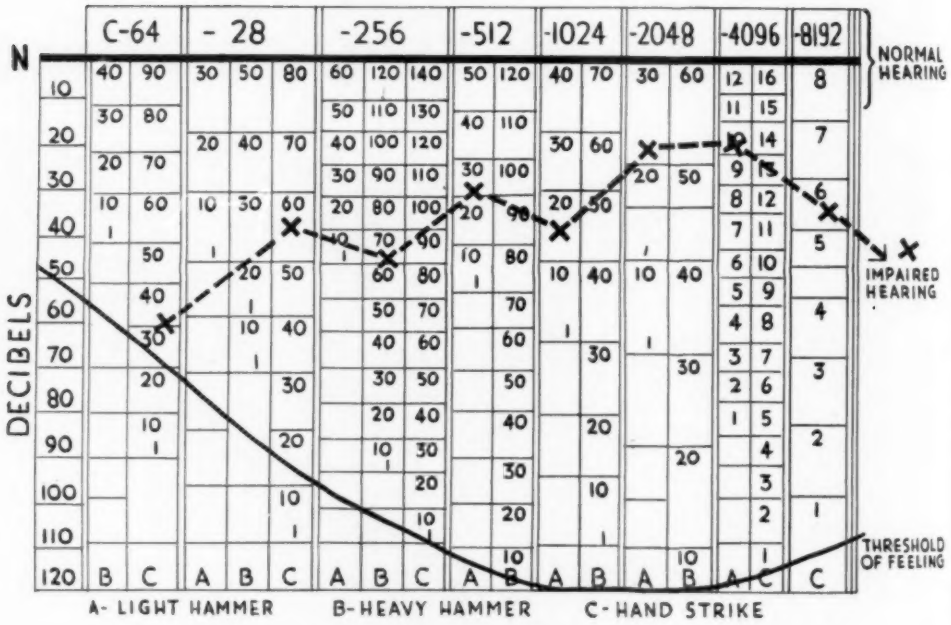

Fig. 4.—Curve of acuity of hearing charted by the method described.

In the stem of the fork is a slot for the insertion of the hammer. One hammer serves the whole series of forks. The hammer is detached after the strike.

In the clinical procedure of testing acuity of hearing the hammer is raised to a horizontal position and dropped. On the rebound it is caught and removed. The second hand of a clock is observed for the duration of audibility (from the instant

of the strike to the instant of loss of audibility in the ear examined). For the number of seconds so noted there is a corresponding space in the column of the chart. A mark is made in this space. The same procedure is followed with the whole series of forks and the marks connected in one continuous curve. The result is the curve of acuity of hearing.

Explanation of the Chart.—For each fork there are three columns, spaced at intervals of several seconds. The total column represents the interval from the instant of the strike to the point of loss of audibility for the normal ear. The first column is spaced for the use of a light hammer. The second column is spaced for the use of a heavy hammer. The third column is spaced for striking by hand with the heavy hammer, using fullest force. (In the last case the maximum intensity is always obtained. For it is characteristic of tuning forks that their maximum intensities are produced by a certain limit of striking force, beyond which an increase in the force of the strike cannot produce a greater intensity.)

Striking by hand is used only rarely and then in the examination of patients that obviously have an impairment near or on the borderline of total deafness.

The purpose of these three columns for the respective manner of striking is to save time in the examination. For moderate impairments the light hammer gives results quickly. If the patient hears nothing with the light hammer strike, then he is tested with the heavy hammer strike. In the average case less than ten minutes is required for the testing of both ears. In other respects the chart is self explanatory.

COMMENT

In my original experiments I calibrated the tuning forks by means of a sound level indicator which showed the maximum intensity of each fork and also the rate of decay per second in decibels. By these data combined with tests of normal ears the spaced columns as they appear in the chart were easily established. These forks, after being calibrated, can be used as the standard for calibrating electrical audiometers. Vice versa, also, an electrical audiometer can be the standard for calibrating the forks. The forks will remain constant in pitch and intensity potentials, there being no wearable and varying elements, such as are necessary in intricate electrical hook-ups. There is no bone conduction factor of error when the sound collector is in contact with the auricle. I have observed that the auricle and the soft canal act as practical insulation against bone conduction. It is a simple experiment to prove this assertion. The use of the sound collector proves this. A patient with increased bone conduction will show increased bone conduction by this method of examination the same as by the usual manner of fork testing (holding the prongs to the meatus for air transmission and pressing the stem of the fork on the mastoid for bone transmission).

SIMPLE INSTRUCTIONS TO ASSURE ACCURACY

The sound collector must be brought in light contact with or close to the ear every several seconds until the sound becomes very faint. Then and only then the collector is pressed firmly over the auricle, removed and pressed on again alternately until the sound is no longer preceived.

The experiments and application of the adduced data which have led to the present precision forks and charting method were tedious efforts in some respects in view of the utter lack of any guiding texts or literature on the subject. The peculiarities of the absorption and transmission of the vibrations of the forks (with the stem in contact or freely suspended) had to be personally discovered

without benefit of an environment of research, and so I shall hope to hear of other otologists with better opportunities for research making use of the data here contributed. In the meantime, in the interests of maintaining standard values of acuity, permission to manufacture these forks has been given to Clay Adams of New York, in association with the Acoustic Research Laboratories of New York.

EASY LIGATION OF BLOOD VESSELS IN CONNECTION WITH TONSILLECTOMY

A New Instrument and Method

FERNAND VISTREICH, M.D., NEW YORK

The control of bleeding which occurs during the surgical removal of tonsils is unquestionably an important part of the operation. The routine procedure

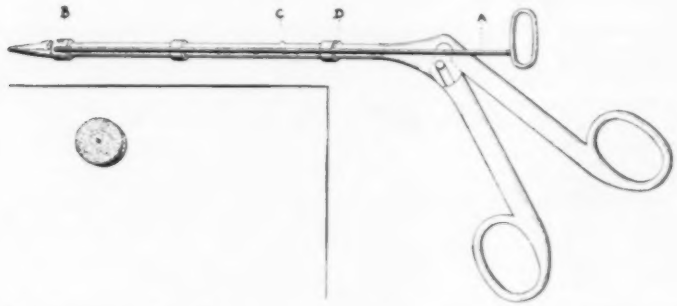

Fig. 1.—Forceps with sliding push ring, *B*, and push rod, *A*. *C* and *D* set the limit of sliding in both directions. Inset, elastic disk enlarged. The actual size is 5 mm. in diameter and 1.2 mm. in thickness.

consists in applying pressure to the tonsillar fossa by means of gauze sponges. In a large per cent of cases this suffices to control hemorrhage. The length of time over which pressure is to be applied is usually not less than three minutes but often considerably more. Unfortunately, even though cessation of bleeding may have been achieved, it is a matter of chance whether bleeding may occur again soon after operation or during early convalescence, if pressure alone is used. A child, especially, may lose considerable blood before the fact that he is bleeding is discovered.

Aside from pressure, the method most frequently used to control tonsillar hemorrhage is clamping of the bleeding points or the application of a catgut ligature around them. The application of a ligature is sometimes difficult, particularly when

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the source of the hemorrhage is the lower part of the tonsillar fossa. The ligature may become loosened and the bleeding be controlled only by suture.

Surgeons have long sought an efficient, quick method to stop hemorrhage during and following tonsillectomy. The instrument about to be described has been designed with this fact in view. It consists of a grasping forceps of the alligator jaw type (fig. 1). A small rubber disk which has a puncture hole in its center is slipped over the slender grasping end of the forceps (fig. 1, inset, and 2 *A*). This disk is very elastic and is 5 mm. in diameter and 1.2 mm. thick. It is applied to the

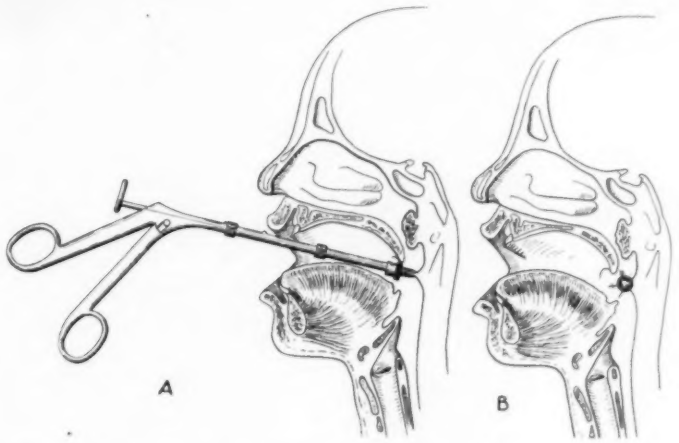

Fig. 2.—*A*, instrument ready to place a ligature. *B*, ligature in position. The rubber disk is presented somewhat enlarged. Note the tissue emerging through the center of the rubber disk.

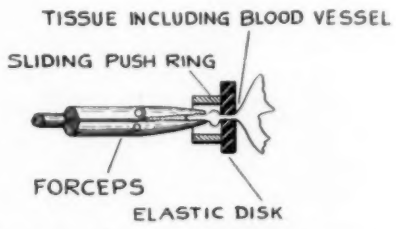

Fig. 3.—Enlarged details of ligation. Note the amount and length of tissue emerging through the center of the rubber disk.

bleeding point by pushing it downward over the end of the forceps by means of a rod which extends from the grasping tip to the handle.

The technic of the procedure is as follows: The bleeding point is seized with the forceps equipped with the rubber disk, and the disk is pushed over the end of the forceps to encircle the tissue held. The transfer of the rubber disk to the tissue is made by pushing the sliding ring downward (fig. 3).

It is an advantage to grasp a substantial portion of tissue with the hemostat. If properly applied (fig. 2 *B*), the elastic tie will remain in position several days.

For experimental purposes, I have left some in the tonsillar fossa as long as one week. Their presence causes no discomfort. They may readily be removed with a grasping forceps at the end of forty-eight hours.

By use of this instrument, all bleeding can be controlled and the time of operation considerably shortened.

Two or more complete instruments should be ready for use on the instrument tray during operation, and a liberal supply of rubber disks should be at hand.

The hemostat is sterilized by boiling; the rubber disks, by the use of alcohol.

Skill in the use of this instrument can readily be acquired by practice on a piece of tough meat.

106 East Eighty-Fifth Street.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

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ADVANCES IN THE FIELD OF ALLERGY AS RELATED TO OTOLARYNGOLOGY DURING THE YEAR 1939

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In the following annual review our aim has been to select a few articles which show the present trend of the literature on allergy. Some of the articles chosen present new ideas. Others repeat studies already reported and are referred to here because of a fundamental importance which should again be called to the attention of the readers.

CAUSES OF ALLERGY

Foods.—Bowen [1] reports 5 cases of urticaria caused by the ingestion of karaya gum. This substance at present is used in many preparations prescribed for increasing the bulk of stools. It is used also in dental powders, tooth paste and in a number of gelatin preparations.

Molds.—Rackemann [2] reviewed the literature on the relation between molds and hay fever and asthma. He concludes that many atypical cases of hay fever may be accounted for by sensitivitiy to molds. The occurrence of molds in household dusts also accounts for the fact that asthma is often limited to certain environments. He calls attention to the difficulties in interpreting cutaneous tests with mold extract and suggests that the specificity of mold extracts may be important.

Durham [3] reports a study of the distribution of Hormodendrum, Alternaria and rust spores. This is a continuation of work previously reported. The data were obtained by a study of some 10,000 samples

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1. Bowen, R.: Karaya Gum as a Cause of Urticaria, Arch. Dermat. & Syph. **39**:506 (March) 1939.

2. Rackemann, F. M.: Molds as a Cause of Hay Fever and Asthma, Tr. Am. Climat. & Clin. A. **54**:194, 1939.

3. Durham, O. C.: Incidence of Air-Borne Fungus Spores: Hormodendrum, Alternaria, and Rust Spores, J. Allergy **10**:40, 1938.

of atmospheric dust caught on oil-coated slides exposed by United States weather observers over several years. He states that Alternaria and Hormodendrum spores are found in the air in greatly varying numbers in all parts of the United States. The total figures for the two are approached by no other air-borne fungus spores except those of the rusts and smuts. There is a striking similarity in the quantitative geographic distribution of Alternaria and Hormodendrum, not only as compared with each other but also as compared with ragweed. Where one is abundant the other two are likely to be abundant.

Harris [4] studied 13 patients allergic to grain dust. Each patient gave a positive intradermal reaction to extracts of wheat dust and oat dust and also reacted to one or more grain smuts. Reactions to grain dust and grain smut were transferred in every patient tested. Symptoms following exposure to grain dust were classified in two varieties: (1) irritative symptoms, which consisted of a burning sensation in the throat and chest and which occurred in both allergic and nonallergic persons, and (2) allergic symptoms, which included sneezing, itching of the eyes, wheezing and asthmatic paroxysms and which occurred in allergically disposed persons. In 4 out of 5 cases the author successfully produced an exacerbation of symptoms by applying cotton pledgets soaked in grain dust extract or smut extract to the inferior turbinate. He suggests a relation between sensitiveness to grain dust and that to grain smuts. A few patients were successfully treated by desensitization. Constitutional reactions were not uncommon during desensitization.

Wittich [5] confirmed an immunologic relation between smuts and their corresponding hosts, the grains.

Cohen, Cohen and Hawver,[6] continuing their study of house dust antigen in cotton linters, describe a "linters extract . . . with which immunologically specific endermal reactions may be obtained in dust-sensitive patients." Well over 90 per cent of clinically dust-sensitive patients gave a 1 plus or larger endermal reaction to a 1 : 50 dilution. Control experiments on normal persons and allergic persons not sensitive to dust gave negative results. They were able to sensitize and shock guinea pigs with linters extract.

Chemicals.—Kern [7] reports a case of asthma and allergic rhinitis due to sensitiveness to phthalic anhydride.

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4. Harris, L. H.: Allergy to Grain Dusts and Smuts, J. Allergy **10**:327, 1939; The Nature of the Grain Dust Antigen, ibid. **10**:433, 1939.

5. Wittich, F. W.: Further Observations on Allergy to Smuts, Journal-Lancet **59**:382, 1939.

6. Cohen, M. B.; Cohen, S., and Hawver, K.: Further Observations on the Nature of the House Dust Antigen, J. Allergy **10**:561, 1939.

7. Kern, R. A.: Asthma and Allergic Rhinitis Due to Sensitization to Phthalic Anhydride, J. Allergy **10**:164, 1939.

Phthalic anhydride is the anhydride of benzene-ortho-dicarboxylic acid (phthalic acid). It has the formula $C_6H_4(CO)_2O$, and is a benzene ring substance. . . . Phthalic anhydride is the starting point for the manufacture of fluorescein and anthraquinone dyes. With glycerol it reacts to form a resin that is used in the paint industry. . . . An unusual feature of the case is the demonstration of circulating specific reagin to a substance of non-nitrogenous nature.

Romanoff [8] reports 3 cases of bronchial asthma caused by exposure to sulfur dioxide fumes in men working about electric refrigerators. None of the patients had a personal or family history of allergy. He states:

. . . There is no immunologic proof of the specificity of sulfur dioxide fumes in initiating attacks of bronchial asthma. It appears more likely . . . that the primary effects are the result of an inflammatory, destructive lesion in the upper respiratory tract, [allowing bacteria to] . . . multiply and gain access to underlying tissue. . . . Sulfur dioxide refrigerants represent an industrial hazard, particularly for individuals with an allergic background.

Miscellaneous Agents.—Rowe [9] reports a case of bronchial asthma and nasal allergy with proved sensitivity to pine pollen. Hyposensitization with specific pine pollen extracts controlled the symptoms.

The late Parlato [10] reports an excellent study of the May fly. Allergic symptoms are believed to have been caused by the inhalation of minute particles of the pellicle. In his study of 589 patients with seasonal hay fever and asthma he found 19 who gave repeated positive cutaneous reactions to extract of the whole May fly. Of these, 7 patients, or a little over 1 per cent of the total, could be proved clinically hypersensitive to May fly. He feels that the May fly should take its place with the caddis fly as an excitant of allergic symptoms.

Kahn [11] reports a case of rhinitis due to amaranth pollen in which cutaneous and ophthalmic tests gave negative results but in which a positive reaction resulted from the direct application of the pollen to the turbinates. After a positive diagnosis had been made from intranasal applications of pollen, unilateral facial acne occurred on the same side. This lesion reappeared at the same site on four different occasions in the course of specific treatment.

Berger [12] reports a case of intermittent hydrarthrosis in which an allergic causation was established. Elimination of offending foods not

8. Romanoff, A.: Sulfur Dioxide Poisoning as a Cause of Asthma, J. Allergy **10**:166, 1939.

9. Rowe, A. H.: Pine Pollen Allergy, J. Allergy **10**:377, 1939.

10. Parlato, S. J.: The May Fly as an Exciting Cause of Seasonal Allergic Coryza and Asthma, J. Allergy **10**:56, 1938.

11. Kahn, I. S.: Sensitization of Skin Induced by Turbinal Pollen Application, Resulting in Facial Acne, J. Allergy **10**:235, 1939.

12. Berger, H.: Intermittent Hydrarthrosis with Allergic Basis, J. A. M. A. **112**:2402 (June 10) 1939.

only caused the disappearance of the swelling of the knee but also relieved gastrointestinal symptoms and vasomotor rhinitis.

Boemer [13] reports several cases to demonstrate an association between infection, arthritis and allergy. He thinks that the three conditions can occur together as a clinical entity. Allergic treatment is suggested.

Ross [14] reports a case of peripheral neuritis in an apiarist following stings by honeybees (Apis mellifica). He thinks the reaction is due to hypersensitivity to allergens in the bee.

Todd, Cohen and Broadbent [15] in a study of 60 children under treatment for allergy found that 75 per cent had gross orthodontic deformity. They explained this as follows:

> In infancy growth is most rapid in the head. . . . More than half the postnatal growth in brain takes place during the first year. Facial growth is less rapid than this, but, since the face is an appendage of the brain case, it cannot fail to follow the cranium in an extraordinarily rapid growth.
>
> All rapidly growing structures are vulnerable, and hence it comes about that facial growth is in greatest danger of multilation during the first year. . . .
>
> The face grows simultaneously in all three dimensions [and] . . . although the major defect may be shown in only one or two [all dimensions may be affected].
>
> In . . . children who have nasal symptoms in early infancy the face will be markedly retarded in growth in all three dimensions. Those whose symptoms begin during the second year have less marked deformities, especially in the lateral expansion of the hard palate; in those whose symptoms begin at five or six years there may be only a slight diminution in either forward or downward growth.

Bourne [16] cites 2 cases in which asthma followed accidental injury to the nose. Neither patient had any allergic manifestation previously, and neither had a family history of allergy. The injuries had produced septal deformity. Complete disappearance of the asthmatic symptoms followed submucous resection. He suggested that nasal injury may be a factor in the causation of asthma.

MECHANISM OF ALLERGY

Stoesser and Cook [17] studied 12 patients with asthma which "had proved intractable under routine allergic management. Various pro-

13. Boemer, L. C.: Infection, Arthritis and Allergy, Laryngoscope **49**:297, 1939.

14. Ross, A. T.: Peripheral Neuritis: Allergy to Honeybee Stings, J. Allergy **10**:382, 1939.

15. Todd, T. W.; Cohen, M. B., and Broadbent, B. H.: The Role of Allergy in the Etiology of Orthodontic Deformity, J. Allergy **10**:246, 1939.

16. Bourne, W. A.: Asthma as a Sequel of Nasal Injury, Brit. M. J. **1**:870, 1939.

17. Stoesser, A. V., and Cook, M. M.: Electrolyte and Water Change in Bronchial Asthma, J. Allergy **11**:65, 1939.

cedures affecting the electrolyte and water metabolism" are reported on as follows:

1. Artificial fever gave . . . transitory benefit in asthmatics whose sodium chloride intake was normal or high before and during treatment.

2. Artificial fever gave striking improvement or complete remissions in asthmatics on continuous low salt diet. . . .

3. Remissions from the low salt intake plus artificial fever could be terminated promptly by adding 1 to 2 gm. of NaCl to the diet. . . .

4. Potassium chloride . . . [in large doses] when added to the special low salt diet [relieved] . . . asthma in milder cases. In more severe cases asthma continued while KCl was taken, but ceased at once when KCl was discontinued. . . .

The foregoing observations suggested that depletion of body water and salt . . . tended to favor remission of asthmatic symptoms. . . . It would appear . . . that sodium, potassium, and water metabolism bear an important relationship to the asthmatic state. It is suggested that drastic salt depletion favors a reduction of asthmatic symptoms. . . .

No positive therapeutic implications are [as yet] warranted.

Sheldon, Howes and Stuart [18] report a study on a relation between sodium and general body water and local tissue edema. Five patients were selected for study in whom attacks of asthma could be started or stopped when desired. They stated:

The asthmatic attacks of our subjects were associated with a considerable loss of body water and a distinct elevation in urinary sodium. The sodium depletion was directly related to the body water loss, as measured by the balance studies. . . .

The water metabolism directly paralleled that of the sodium. . . .

The loss of body fluid occurred in spite of a . . . [delay of water in] the the shock organ. It would follow that a redistribution of fluid and electrolytes . . . takes place . . . [which is independent of the water] content of the shock organ tissues.

The possibility of "a new approach to the management of allergic disease through an understanding of water and sodium" movement is suggested.

Phillips [19] reports the study of a group of allergic persons who were exposed for the first time "to the pollen of sugar beet as the result of the introduction of a new industry into the region where they resided." In the second year of exposure a number of positive cutaneous tests were observed in patients who were not clinically sensitive to beet pollen. "In the third year skin tests were strongly positive, and intense symptoms of pollinosis occurred in a considerable number of the

18. Sheldon, J.; Howes, H., and Stuart, G.: Observations on Total Water and Sodium Exchanges in Asthmatic Patients, J. Allergy **11**:1, 1939.

19. Phillips, E. W.: Time Required for the Production of Hay Fever by a Newly Encountered Pollen, Sugar Beet, J. Allergy **11**:28, 1939.

patients." It seems from this series of cases that "two seasons of exposure to a newly encountered pollen were required to induce clinical sensitivity."

Watson and Kibler [20] present further evidence to support the idea that allergy can be an etiologic background for bronchiectasis.

> A study of . . . 46 cases of bronchiectasis . . . reveals that a high percentage was found to have definite evidence of allergy based on the presence of hay fever, asthma, nasal polyps, atopic dermatitis, and abnormal amounts of eosinophiles in nasal or bronchial secretions. . . . Bronchiectasis . . . can be favorably influenced by allergic management. . . . The common association of sinusitis and bronchiectasis can be explained.

IMMUNOLOGIC STUDIES

Tuft, Wenger and Frankel [21] describe a method of preserving serum containing allergic antibodies or reagins, which they consider superior to that of Lichtenstein.[22] The principle of the method (previously described by Mudd and Flosdorf with their associates [23]) depends on a rapid freezing of the serum, followed by its rapid dehydration under high vacuum pressure. The resulting product is a porous solid in which reagins remain potent for months. The finished product dissolves quickly and completely in distilled water. This procedure is called lyophilization.

Cohen [24] has used this method, of lyophilization, in the preservation of pollen and dust extract. The desiccated material may be stored in rubber-capped bottles and redissolved in diluting fluid when needed for use. By this method, fresh, potent, accurately standardized extract can be made available at all times.

Langner and Kern [25] found that the "blocking or inhibiting antibody" of Cook can be preserved for eight months or more in lyophilized serum.

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20. Watson, S. H., and Kibler, C. S.: The Role of Allergy in Bronchiectasis, J. Allergy **10**:364, 1939.

21. Tuft, L.; Wenger, L. J., and Frankel, J. J.: Preservation of Reaginogenic Serum by Lyophilization, J. Allergy **10**:27, 1938.

22. Lichtenstein, M. R.: Preservation of Reagin in Dried Serum, J. Allergy **4**:239, 1933.

23. Mudd, S.; Reichel, J.; Flosdorf, E. W., and Eagle, H.: Preparation of Lyophile Serum, Proteins and Complement, J. Immunol. **26**:341, 1934. Flosdorf, E. W., and Mudd, S.: Procedure and Apparatus of Preservation in "Lyophile" Form of Serum and Other Biological Substances, ibid. **29**:389, 1935.

24. Cohen, M. B.: A Note on a New Method of Preserving Pollen and Dust Extracts, J. Allergy **10**:385, 1939.

25. Langner, P. H., Jr., and Kern, R. A.: Studies on Immunology of Hay Fever, J. Allergy **10**:1, 1938.

Bernstein, Rubin and Feinberg [26] studied the effect of antigen concentration on the rate of absorption of antigen solutions when injected. They concluded that "reactions are apt to occur more frequently and earlier when small concentrated volumes [of antigen] are injected."

Waldbott, Ascher and Rosenzweig [27] report serial studies of blood sugar, blood pressure, and white blood cell counts in 14 cases of allergic shock. They found that "a. The average blood sugar showed an immediate transient rise followed by a prolonged hypoglycemia. b. The blood pressure showed a sharp fall which varied [with the degree] . . . of shock. c. A definite leukopenia was encountered."

Hansel [28] emphasizes again

> the value of the cytologic examination of the nasal, sinus and bronchial secretions as an adjunct in diagnosis and also as a guide in determining the clinical course of allergy of the upper and lower respiratory tracts . . . [particularly in] cases presenting secretory and vascular disturbances in the nose in which the symptoms are not typical of allergy. . . .
>
> In the management of patients with respiratory allergy, an acute exacerbation of symptoms may be caused by an allergic contact or by an acute infection. Cytologic studies are of indispensable value in the differentiation of these two conditions. . . .
>
> By . . . correlation of the allergic history and cytologic findings we have found that among children giving a history of frequent colds and bronchitis, there is a significant number who have nasal allergy.

TREATMENT

Keeney and his associates [29] suggest the use of epinephrine in oil in cases in which slow absorption of epinephrine is desirable. They give intramuscularly 2 mg. of epinephrine in 1 cc. of peanut oil and find that the hyperglycemic and cardiovascular response to it is prolonged. It is important to use dry sterilized syringes and needles to prevent contamination with water.

"Ten patients with chronic asthma who had been taking frequent daily injections or inhalations of epinephrine hydrochloride received [equal] relief . . . with 0.65 to 2 cc. doses of epinephrine in oil." The effect of one dose was inclined to last for from eight to sixteen

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26. Bernstein, T.; Rubin, S. S., and Feinberg, S. M.: The Effect of Volume of an Antigen Solution on Its Rate of Absorption, J. Immunol. **36**:309, 1939.

27. Waldbott, G. L.; Ascher, M. S., and Rosenzweig, S.: Serial Studies of Blood Sugar, Blood Pressure, and White Blood Cell Count in Allergic Shock, J. Allergy **10**:220, 1939.

28. Hansel, F. K.: Further Observations on the Cytology of the Nasal Secretions in Allergy, J. Allergy **10**:251, 1939.

29. Keeney, E. L.; Pierce, J. A., and Gay, L. N.: Epinephrine in Oil: A New Slowly Absorbed Epinephrine Preparation, Arch. Int. Med. **63**:119 (Jan.) 1939. Keeney, E. L.: Epinephrine in Oil: Its Effect in the Symptomatic Treatment of Hay Fever, J. Allergy **10**:590, 1939.

hours. For immediate relief, however, aqueous solutions proved superior. Prolonged relief followed the injection of epinephrine in oil in 30 of 35 patients with seasonal or perennial hay fever. The authors think that epinephrine in oil is a good symptomatic remedy, which can be used to advantage in combination with specific treatment. The possibility of sensitizing patients to some constituent of the oil must be kept in mind.

Murphy and Jones [30] report 9 cases of intractable asthma in which the number of injections of epinephrine required was remarkably reduced by the use of epinephrine in oil.

Cohn [31] reports 4 cases in which constitutional reactions followed the administration of epinephrine in peanut oil. The patients had "nausea, vomiting, chills, vesicular urticaria, cyanosis, increased dyspnea, and swelling and edema of the forearm." The use of peanut oil as a vehicle for epinephrine was questioned because of the possibility of an underlying hypersensitiveness to peanut oil.

Spain, Strauss and Fuchs [32] describe a new preparation of epinephrine which

> by delaying the rate of absorption, lengthens the period of its influence upon the patient, thus lessening the frequency of administration. . . . [The medium used to retard absorption] is nontoxic, nonantigenic, reasonably stable, and can be easily self-administered. . . . The mixture to which epinephrine is added contains gelatin, sodium chloride, chlorobutanol, sodium bisulfite, glycerin, and water. Gelatin is chiefly responsible for the decreased rate of absorption of this mixture. . . . [A 1:500 epinephrine solution is used in contrast to the 1:1,000 aqueous solution. It was found, in a study of 50 patients with moderately severe or severe asthma] that an injection of 1 cc. of gelatin epinephrine twice daily would . . . control the asthmatic condition. In some instances doses of ordinary (aqueous) epinephrine would be required in addition, but the demands for this would be reduced from one to two doses for the twenty-four hours. . . .
>
> The gelatin-epinephrine mixture . . . can easily be self-administered by subcutaneous injection, in contrast to the epinephrine in oil preparation of Keeney, which [should] . . . be given intramuscularly. . . . It is possible that the risks . . . with other therapeutic agents administered by injection might be minimized by the addition of gelatin. . . . Among such agents are diphtheritic, scarlatinal, and streptococcic toxoids, pollen extracts, and, particularly, horse serum preparations.

Bloom [33] reports 50 to 100 per cent relief obtained in 29 cases of hay fever by the use of potassium chloride. The rationale for the

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30. Murphy, J. A., and Jones, C. A.: Slow Epinephrine in the Treatment of Chronic Asthma, J. Allergy **10**:215, 1939.

31. Cohn, J.: Unusual Reactions to Slow Epinephrine, J. Allergy **10**:459, 1939.

32. Spain, W. C.; Strauss, B. A., and Fuchs, A. M.: A Slowly Absorbed Gelatin-Epinephrine Mixture, J. Allergy **10**:209, 1939.

33. Bloom, B.: The Use of Potassium Salts in Hay Fever: Preliminary Report, J. A. M. A. **111**:2281 (Dec. 17) 1938.

use of this drug evolves about a theory that allergy is a disturbance of electrolyte metabolism. Pharmacologically, potassium chloride is similar to epinephrine in action, and it is suggested that the effect of epinephrine is due to potassium migration. The dosage prescribed was 5 grains (0.32 Gm.) of potassium chloride in water, administered three times daily.

Abt [34] reports striking results with oral administration of potassium chloride for children who have both hay fever and asthma. He noticed that the swelling and pallor of the nasal mucous membrane in allergic rhinitis disappeared in three to five days and that the discharge was decreased. He thinks that the action of potassium is to displace sodium in the tissues, thus producing local dehydration of the tissues.

Harley [35] states, "Oral potassium chloride therapy . . . [following the method outlined by Bloom], failed to produce a significant degree of improvement in a group of 43 allergic patients." This has been the experience of the reviewers.

Rusk and his associates [36] found elevation of the potassium content of the serum in patients suffering from asthma and urticaria. They feel that potassium metabolism is not yet clearly understood, but assume that most of the potassium in the body is stored in the tissues and that the blood acts as a transport medium. The administration of potassium chloride presumably replaces the depleted potassium content of the tissues. Patients treated with "high protein, low sodium, acid-ash diet with added potassium chloride" showed promising clinical results. In contrast to this, Cohen [37] found no benefit from the treatment suggested by Rusk. In 8 cases of chronic urticaria he obtained doubtful results.

Zeller [38] reviews the literature on oral therapy with ragweed pollen and presents a "clinical study of 42 cases of ragweed pollen hay fever treated by oral pollen administration." He doubts the advantage of oral therapy and found that treatment by hypodermic injection is distinctly better. He precipitated more reactions with oral therapy than with hypodermic injection.

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34. Abt, A.: Note on Oral Administration of Potassium Chloride in the Treatment of Hay Fever, Nasal Allergy, Asthma and Sinusitis, Am. J. M. Sc. **198**:222, 1939.

35. Harley, D.: Note on Oral Potassium Chloride Therapy in Asthma, Hay Fever, Urticaria and Eczema, J. Allergy **11**:38, 1939.

36. Rusk, H. A., and Kenamore, B. D.: Urticaria—New Therapeutic Approach, Ann. Int. Med. **11**:1838, 1938. Rusk, H. A.; Weichselbaum, T. E., and Somogyi, M.: Changes in Serum Potassium in Certain Allergic States, J. A. M. A. **112**: 2395 (June 10) 1939.

37. Cohen, A. E.: The Treatment of Chronic Urticaria with a High Protein, Low Sodium Acid-Ash Diet, with Added Potassium Chloride, J. Allergy **10**:61, 1938.

38. Zeller, M.: Oral Ragweed Pollen Therapy, J. Allergy **10**:579, 1939.

Black [39] concludes from his study that oral therapy with pollen is of value in some cases but that the results obtained are not nearly as satisfactory as with hypodermic administration of the antigen. In 3 of Black's patients tolerance for hypodermic doses developed after oral therapy.

London [40] states that little if any of the active principle of ragweed pollen is absorbed after its oral administration. He says, "Patients adequately treated by the subcutaneous method can expect no further benefit from oral ingestion of pollen."

Pollia [41] reports 3 cases of reaction after the oral administration of pollen. The symptoms were dermatitis, urticaria and aggravation of nasal symptoms.

Brown [42] reports beneficial results from the use of theophylline with ethylenediamine (aminophylline) in the treatment of status asthmaticus, or intractable asthma. He states, "Theophylline is also of value in the symptomatic treatment of mild or moderately severe attacks of bronchial asthma."

Meyer and Schotz [43] relieved severe intractable asthma by the use of cyclopropane anesthesia.

Farmer [44] inhibited fatal anaphylaxis in sensitized guinea pigs by the use of ethyl carbamate. On the basis of this experiment, he administered ethyl carbamate orally in 30 cases of bronchial asthma. A dose of 2 to 4 grains (0.13 to 0.26 Gm.) daily seemed beneficial in 14 cases.

Maytum and Leddy [45] report on roentgen therapy in 161 patients with moderately severe asthma. An anterior and posterior field over the mediastinum were irradiated. They suggest that the beneficial effects of roentgen therapy may be because "the roentgen rays decrease the secretory power of the mucous glands in the trachea [and] liberate antibodies by destruction of leucocytes." Another factor may be "the analgesic effect of roentgen rays on the nervous system." Twenty-four per cent of their patients were markedly relieved and 16 per cent

39. Black, J. H.: The Oral Administration of Ragweed Pollen, J. Allergy **10:** 156, 1939.

40. London, McK.: Combined Oral and Subcutaneous Treatment for Ragweed Pollinosis, J. Allergy **10:**453, 1939.

41. Pollia, J. A.: Dermatitis, Urticaria and Aggravation of Nose Symptoms from Oral Administration of Pollen Suspensions, California & West. Med. **50:**25, 1939.

42. Brown, G. T.: Aminophyllin in Asthma, J. Allergy **10:**64, 1938.

43. Meyer, N. E., and Schotz, S.: The Relief of Severe Intractable Bronchial Asthma with Cyclopropane Anesthesia, J. Allergy **10:**239, 1939.

44. Farmer, L.: The Use of Urethane in Symptomatic Treatment of Bronchial Asthma, J. Lab. & Clin. Med. **24:**453, 1939.

45. Maytum, C. K., and Leddy, E. T.: Roentgen Treatment of Asthma, J. Allergy **10:**135, 1939.

moderately relieved for from one to several months. Fourteen per cent showed marked relief when roentgen and other types of therapy were used. For 46 per cent the results were failures.

Leriche and Fontaine [46] report on the result in 11 cases of bronchial asthma treated by stellectomy. The operation was either unilateral or bilateral. In about 50 per cent of the cases good results were obtained. They suggest that infiltration of the stellate ganglion with an anesthetic may be done in an effort to predict the result which might be obtained by stellectomy. This must be considered for the present a rather radical experimental measure.

Vollmer [47] treated 7 asthmatic children by insulin shock. He states that all were benefited, at least temporarily. Fifteen to twenty-five treatments were given over one and a half to three months. Doses as high as 40 units of insulin were given. The hypoglycemic reaction was carefully controlled by the use of dextrose. The "effect is ascribed to a secondary endogenous adrenalin production" in the patient and a possible "compensatory hyperfunction of the adrenal system."

Prince and Secrest [48] succeeded in protecting persons sensitive to bee, wasp or ant bites by hyposensitizing them with whole bee extract. They believe that certain insect groups possess a common antigen.

Piness and Miller [49] report that in 43 per cent of a large group of asthmatic children, tonsillectomy had been advised by a physician for the relief of asthma. Not only does this procedure fail to relieve asthma, but in 17 per cent of allergic tonsillectomized children it seemed actually to have initiated the asthmatic state and in many more to have aggravated mild symptoms. It is pointed out that the obvious cause of this unfortunate state of affairs is that allergic symptoms were mistaken for infectious symptoms and that the tonsils were thought to share in the infection. One of the distinct features of allergy is hyperplasia of the lymphoid tissue and as a result enlarged tonsils are characteristic findings.

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46. Leriche, R., and Fontaine, R.: Les résultats éloignés du traitement chirurgical de l'asthme bronchique par la stellectomie, Presse méd. **47**:243, 1939.

47. Vollmer, H.: Controlled Insulin Shock Treatment of Asthmatic Children, Arch. Pediat. **56**:223, 1939.

48. Prince, H. E., and Secrest, P. G., Jr.: Use of Whole Bee Extract in Sensitization to Bees, Wasps and Ants, J. Allergy **10**:379, 1939.

49. Piness, G., and Miller, H.: Allergy of the Upper Respiratory Tract in Infancy and Childhood, J. A. M. A. **113**:734 (Aug. 26) 1939.

Abstracts from Current Literature

Ear

BRAIN HERNIA: A POSTOPERATIVE COMPLICATION IN OTOLOGY. COLBY HALL, Ann. Otol., Rhin. & Laryng. **49**:291 (June) 1939.

"Brain hernia" is herniation of the substance of the meninges and the brain through a defect in the dura and into a mastoidectomy wound. Hernias are divided into (1) immediate hernias, which occur immediately on incision of the dura, and (2) secondary hernias, which are postoperative. For hernia of the brain to occur there must be an opening in the bone, an opening in the dura and an increase in intracranial pressure. The increase in intracranial pressure is due to an increase in the volume of the brain produced by an abscess or tumor or by edema of the brain due to infection or irritation and not by increased formation of spinal fluid. A small dural defect does not preclude the formation of a large hernia of the brain. A small dural opening is more apt to produce strangulation of the hernia, and there is more likelihood of hernias which develop through a larger opening subsiding. The hernia may contain brain tissue alone, clean or infected, or pus from the main abscess, and a hernia of the temporal lobe may contain a prolongation of the lateral ventricle. In most strangulated hernias the tissue degenerates, finally becoming cicatricial, and eventually is covered with normal skin. All or most of the mass of a nonstrangulated hernia recedes into the cranial cavity and is epithelialized.

Immediate hernias usually disappear after evacuation of the abscess. Secondary hernias occur from within several days to several weeks postoperatively, first appearing as a soft granular mass. This becomes larger as it protrudes and is elastic and irreducible; it is reddish with no signs of necrosis.

There appears to be less danger of hernia if exploration for a possible abscess of the brain is done through a clean field, unless a discharging sinus is present. Protecting adhesions about a dural opening should not be disturbed, and all possible trauma should be avoided.

Early treatment should stress avoidance of trauma, prevention of infection and lowering of intracranial pressure. Lumbar punctures should be done with extreme caution, and intravenous administration of hypertonic solutions, such as 50 per cent dextrose, is more rational.

The author concludes that hernia of the brain in operations on the mastoid is usually avoidable and that the prognosis is dependent on the coexisting pathologic condition and the methods of treatment. He reports a case with recovery.

M. V. MILLER, Philadelphia.

DISCUSSION ON MALIGNANT DISEASE OF THE EAR (EXCLUDING THE PINNA). Proc. Roy. Soc. Med. **32**:1087 (July) 1939.

Mr. Philip Scott based his discussion on an analysis of 70 cases of malignant disease of the ear, of which 12 had not been previously published. He cited statistics tending to show that malignant disease of the ear, excluding the pinna, is rather rare. Among the factors which may arouse suspicion of malignancy are: (1) toughness of granulations when touched with a probe, (2) recurrence after removal and tendency to bleed easily, (3) persistence of meatal infection in spite of cleansing treatment, (4) pain on chewing and (5) presence of granulations or papillomas attached to the deep meatal wall.

Concerning the pathologic picture Scott stated that malignant disease of the ear is divided into four groups: (1) carcinoma, (2) sarcoma, (3) rodent ulcer and

(4) endothelioma. Carcinoma, by far the commonest type, may be primary or secondary, is nearly always squamous cell and starts in the external auditory meatus in the majority of instances. The sarcomatous type causes primary ulceration in the meatus and does not involve the tympanum until late. The rodent ulcer grows more slowly and recurs persistently. The treatment recommended consists of meatal operation when there is apparently no involvement of the drum and radical mastoid and meatal operation when the lesion has involved the drum or middle ear. Both types of operation are followed by diathermy or radiotherapy. Detailed reports of 5 cases of malignant disease of the ear were presented by Mr. Scott.

Mr. Lionel Colledge, in discussing carcinoma of the middle ear, emphasized the rarity of the condition and mentioned that occasionally it occurs as a secondary growth. He cited 2 cases in some detail.

Mr. Musgrave Woodman briefly reviewed the results obtained by treatment in 7 cases. Three patients were alive and free from recurrence.

Mr. F. C. Ormerod, Mr. McCay, Mr. Sydney Scott, Mr. Herbert Tilley and others cited interesting features of cases with which they had come in contact.

CAMPBELL, Philadelphia.

A STUDY OF VESTIBULAR PHYSIOLOGY AND PHYSIOPATHOLOGY. K. ARSLAN, Arch. ital. di otol. **51**:258 (May) 1939.

The application in hundreds of cases of the turning test according to the Buys-Fischer technic has shown the constant lack of the well known phenomena of nausea, vomiting, pallor, sweating and salivation following the tests. Since the sensation of rotation, nystagmus and tonic reflexes appeared with more precise and higher values than when other, less exact, tests were used, the deduction is warranted that the former phenomena are caused by a repercussion on the vegetative nuclei of irregular vestibular stimuli, either at the level of the cortical vestibular centers or at the site of the vestibular nuclei. These clinical observations were fully confirmed by Cojazzi in a series of researches on a group of normal persons, examined with the Buys-Fischer technic with a negative angular acceleration of standard value (630 degrees and 2 seconds). He also registered arterial pressure, frequency of the pulse and respiratory rhythm. Thereafter, Arslan conducted experiments with a more sensitive control on 50 rabbits, investigating the hemodynamic reflexes from vestibular stimulation by rotation on the turning chair of Fischer-Tönnies. All known precautions were taken to obviate other extralabyrinthine stimuli. The appearance of perrotatory and postrotatory nystagmus was noted; arterial pressure was registered on a kymograph affixed to the chair. Narcotics (ethyl carbamate [urethane] and ether) were administered to one group. The results of the experiment were that in most of the animals no change in the curve of the arterial pressure was noted. When modifications of the hemodynamic curve appeared, it was almost always possible to attribute them to extravestibular factors.

It is assumed that vestibulovegetative reflexes from labyrinthine stimulation are connected with irregular types of excitation, which cause diffusion of the excitation from the vestibular nuclei to the bulbar vegetative nuclei.

DENNIS, San Diego, Calif.

THE SYNDROME OF GRADENIGO DUE TO AN UNUSUAL CAUSE. G. ZANZUCCHI, Arch. ital. di otol. **51**:323 (June) 1939.

A case of exenteration of the mastoid cells on the right side in a woman aged 41, who had had chronic otorrhoea since childhood, is reported. A few days after the operation the patient began to have pain in the forehead and the right parietal region, extending to the occiput. Lumbar puncture was followed by paralysis of the right external rectus muscle, vomiting and severe headache. The paralysis lasted a few days.

The pain in the head was attributed to a focus of osteitis in the petrous tip that irritated the gasserian ganglion. The paralysis of the abducens nerve was attributed to lowered intracranial pressure from the spinal puncture, which caused hyperemia and consequent compression of the nerve.

DENNIS, San Diego, Calif.

ISOLATED DISEASE OF THE OTOLITHIC APPARATUS. L. ABBATE, Arch. ital. di otol. **51**:341 (July) 1939.

After reviewing the functions of the otolithic apparatus and discussing the contradictory opinions of various writers, Abbate assumes that any movement whatever, whether pressure or traction, of the otolithic membrane is capable of exciting the sensory epithelium of the maculas. In man, excitation of the otolithic apparatus in pathologic conditions provokes nystagmus. In 1921 Bárány described a case of isolated disease of the otolithic apparatus characterized by vertigo and nystagmus in a certain definite position of the head which continued as long as the head was retained in that position. Abbate here reports illustrative cases, in which the condition was characterized by nystagmus and vertigo when the head was in a given position and at no other time but in which the reflex was quickly exhausted, lasting only eighteen to twenty seconds. The short duration is ascribed to the lightness of the disease and to the fact that it was retrogressing. The fact that the disturbance did not begin until the head arrived at the optimum position for stimulation of the otolithic apparatus shows that a maximum stimulus was necessary to evoke the almost latent irritation. The hyperexcitability of the labyrinth in the first case was indicated by the short time of latency in the caloric test. The use of some apparatus for the attaining of the desired position of the head without bending the neck is advised.

DENNIS, San Diego, Calif.

SPONTANEOUS HEMORRHAGE FROM THE CAROTID ARTERY IN ACUTE SUPPURATIVE OTITIS MEDIA. E. URBANTSCHITSCH, Monatschr. f. Ohrenh. **73**:390 (June) 1939.

A case in which acute otitis media with mastoiditis developed in an adult after scarlet fever, with fatal erosion of the internal carotid artery, is reported. As a rule, such erosion occurs in chronic conditions, such as cholesteatoma and tuberculosis, but in this instance the necrosing scarlatina anginosa, ascending through the eustachian tube, may have destroyed the bony wall and eroded the artery, thus causing the bleeding. Most likely, the bodily resistance was diminished, too, through a diabetic state. Clinically, the patient did not exhibit any signs of severe peritubular infection.

LEDERER, Chicago.

CHRONIC SUPPURATION OF THE MIDDLE EAR AND VITAMIN C. M. BAER, Monatschr. f. Ohrenh. **73**:394 (June) 1939.

The difference between the findings of the author and Chimani's results may be due to the variation in the living conditions of the populations examined. The author believes that the average Swiss population is better fed than are the populations whom he examined, who had nutritional deficiencies resulting from the war. Furthermore, experiments based on the influence of vitamin C on otitis media should not be discouraged by these differences of opinion.

LEDERER, Chicago.

THE CAROTID CANAL AND ITS CONTENTS IN RELATION TO SUPPURATION OF THE TIP CELLS OF THE PETROUS PYRAMID AND THE SURGICAL MANAGEMENT. ROBERTO PODESTA, Pract. oto-rhino-laryng. **2**:133 (July) 1939.

The author has shown that the petrosal portion of the carotid artery loses the elastic fibers of the tunica media and so is differentiated from the cervical portion.

Yet there is no appreciable difference in the thickness of the wall of the vessel. He is one of the advocates for the belief that the space between the adventitia and the bony wall of the canal is filled by the plexus venosus pericarotidis and the sympathetic nerve structure. He states that when this periadventitial space is markedly developed the carotid artery is placed farther from the bony wall of the canal and that the reverse also is true. The size of this space is an important factor in any surgical procedure about the petrous tip, particularly in Ramadier's operation for petrositis. Its variability should not be underestimated, for it may present a serious danger. This space being borne in mind in cases of suppuration of the petrous tip, in which the periadventitial space has been penetrated by pus (as can be evidenced by the Horner syndrome), Ramadier's technic of evacuation and drainage is important.

An apical abscess can produce changes in the arterial wall, especially in the adventitia. The author has cited a case in which a mass of thickened granulation tissue extended from the arterial wall directly to the apical abscess. The bony wall of the canal was resorbed, so that the vascular nervous contents of the periadventitial space were in direct communication with the apical abscess. The author is of the opinion that this was one method by which thrombosis of the carotid plexus can occur, and, by extension, produce thrombosis of the cavernous sinus. This also may leave an easy avenue for laceration of the canal in the course of a surgical operation. When the artery is placed rather deeply within the bony wall of the canal and the thickness of the periadventitia is increased, the danger of an injury in the course of an operation is lessened. The plexus venosus pericarotidis shows marked variation in size in different patients. The author has presented sections which show that there is marked variation in the thickness in the periadventitial space, which becomes wider as the artery approaches the petrous apex and still wider in the vicinity of the cavernous sinus.

He concludes his discussion by emphasizing the relative importance of this space in Ramadier's operation.

PERSKY, Philadelphia.

OTITIS MEDIA IN TWINS. YUHEI NISHIURA, Ztschr. f. oto-rhino-laryng. **45**:718 (July) 1939.

The author reports his observation on 3 pairs of identical twin brothers, aged 3 months, 8 years and 15 years, and 1 of a pair of dissimilar sisters, aged 12 years, in whom acute otitis media developed.

In the 3 pairs of identical twins the onset, the progress, the amount and character of otorrhea and the roentgen observations on the mastoids were identical, though the appearance of the typanic membranes was different during the course of the disease.

In the dissimilar twin sisters, aged 12 years, both mastoids were underdeveloped. Otitis media developed in only 1 sister, two weeks after an acute cold. The patient had numerous attacks of otitis media, while her twin sister was perfectly free from aural infection.

The author also conducted a comparative study on the nose, paranasal sinuses, teeth and larynx in the identical twins and found them similar.

HARA, Los Angeles.

Pharynx

DYSKERATOSIS OF DARIER, OF EXCLUSIVE ORAL LOCALIZATION. L. ABBATE, Arch. ital. di otol. **51**:520 (Oct.) 1939.

Darier gave the name psorospermosis to the disease described by him, but later investigators showed that it consisted of an abnormal and imperfect cornification of the epithelium. Nothing is known of the etiology or pathogeny of the disease, and treatment has had little influence on its course. It appears to be hereditary and familial, arises between the ages of 8 and 16 years and generally persists for

life. Except for slight pruritus in some persons, it is subjectively silent. The sites of selection are the areas vulnerable to seborrhea. Oral localization has been previously observed, but only in association with widespread cutaneous lesions. On the hard palate the lesions are typical; in other oral areas, as the gums, cheeks and tongue, the type is somewhat modified. The typical lesion is an isolated, raised papule, umbilicated and cornified, but in the mucosa the papules form groups, with a slightly hyperemic base. Abbate observed the condition, limited to the mouth, in a man aged 50 who consulted him for mucous cysts of the nasal vestibule. The dyskeratosis, discovered incidentally, was localized in the mucosa of the hard palate, gums, cheeks and tongue. There were no cutaneous lesions. The coexistence of these two distinct diseases in the same region, the superior maxilla, suggests the possibility that they have a common origin, the assumption being that both are the expression of disordered embryonal development, such disorder being manifested through the action of endogenous or exogenous agents.

DENNIS, San Diego, Calif.

ABSCESS OF THE PARAPHARYNGEAL LYMPH GLANDS FOLLOWING INFECTIONS OF THE THROAT. RICHARD WALDAPFEL, Pract. oto-rhino-laryng. **2**:69 (April) 1939.

Waldapfel groups the complications of angina, or infections of the throat, into: (1) the hematogenous form, in which an infection from the tonsils and the thrombosed tonsillar veins may pass directly into the blood stream without involvement of the cervical or pharyngeal glands and without formation of an abscess; (2) the lymphogenous form, in which infection of the blood stream may come from the regional infected glands or abscess, causing periphlebitis or thrombophlebitis of the larger veins, and (3) the interstitial or phlegmonous form, in which there is an invasion of the parapharyngeal spaces, either toward the mediastinum or cephalad, with or without involvement of the veins, and either proximal or distal to the primary focus of infection. It is the third group that he emphasizes in his discussion, that is, that in which frank abscesses occur in the pharyngeal spaces.

He presents a group of patients in whom inflammatory swelling in the neck followed infection of the throat. While this infection may be recent and rather severe, it is not necessarily always so, since some of his patients complained of only the mildest and most transient symptoms referable to the throat. The swelling in the neck varies from the size of a plum to that of a small apple. It is usually rather hard, somewhat painful to the touch and generally adherent and the overlying skin is not freely movable. However, fluctuation is not always present. The tonsils invariably appear rather innocent, in that they do not show either an acute process or any evidence of the origin of the infection. The pharynx is usually asymmetric because of the swelling of the lateral oropharynx or hypopharynx. The temperature in his cases was not particularly significant, ranging from subnormal to only slightly elevated. However, when he observed a marked sudden rise of temperature, he always suspected a generalized spread of the infection. The local symptoms are usually only slight in the early stages. Frequently pain is referred to an ear, and then, with the increase in swelling, there is some difficulty in swallowing and some limitation of motion of the head. Pathologically, there is evidence of an abscess of the cervical lymph glands which extends and spreads into the parapharyngeal spaces. The course of this abscess varies. First, complete resolution with resorption of the exudate and complete return of the gland to normal size and function may occur. Second, contact infection of the veins in the vicinity may develop, with subsequent thrombophlebitis and septicemia. This usually is due to a spread of the infection, arising from the glands that surround the regional veins and thus, by contiguity, causing the thrombophlebitis. In these cases, evidence of encapsulation of the diseased process was not usually observed. Finally, the third course is breaking down of the glands and formation of an abscess. This is a slow progressive course, the glands usually becoming confluent; a rather dense capsule is formed, and the abscess slowly spreads both

externally toward the skin and internally into the parapharyngeal spaces. Because of the slower course and the accompanying inflammation, adhesions and pocketing of the subcutaneous tissues are frequent. The cause of the differentiation into the three pathologic groups is uncertain, but the author suggests that it may depend on either the virulence of the organism or the resistance of the patient. He differentiates cervical adenopathy from actinomycosis, glandular involvement in leukemia and other dyscrasias of the blood, malignant adenitis (which may be metastatic from another source) and chronic cervical lymphomas.

The treatment in the first stage is expectant, that is, application of antiphlogistics—heat, infra-red rays and short wave therapy. The abscess rarely ruptures spontaneously unless there is an extensive underlying disease or complication. However, should the infection continue into the second stage, with a progression of symptoms, such as laryngeal edema, a sudden rise in temperature, chills or a marked spread of the infection to the vertebrolaryngeal spaces, as seen by roentgen examination, surgical intervention is necessary. The external approach should be used. The postoperative course is usually uneventful, unless the patient has generalized septicemia, which must then be treated per se.

In conclusion, the author states that the connective tissue of the skin has two main roles. It can favor the spread of a suppurative process in either an upward or a downward direction, and, secondly, it is capable of encapsulating this process and so limiting its progress. It is in this manner that it plays an important role in complications of any infection of the throat.

PERSKY, Philadelphia.

Larynx

LARYNGEAL TUBERCULOSIS. PIQUET, BOURY and CANONNE, Rev. de laryng. **60**:313 (April) 1939.

Laryngeal tuberculosis is occasionally found in an apparently healthy patient. Latent pulmonary tuberculosis is discovered by careful examination. In general, vegetative masses develop, although infiltration and deep ulceration are common. Clinical diagnosis is difficult, even impossible. Biopsy may not be conclusive. The state of the laryngeal lesion parallels that of the pulmonary one; hence the treatment must be directed to the pulmonary condition. The laryngeal lesion may heal spontaneously or may require galvanocautery.

BATSON, Philadelphia.

INDICATIONS FOR AND ADVANTAGES OF TRANSVERSE INCISION OF THE SUPERFICIAL TISSUES IN TRACHEOTOMY. E. PALLESTRINI, Arch. ital. di otol. **51**:234 (May) 1939.

Pallestrini advocates the use of a transverse incision in the soft tissues in tracheotomy, especially in cases in which the trachea is compressed or dislocated by an extratracheal growth or in which the operation is performed as a preliminary to external operations on the larynx or pharynx. In his experience in many cases, the cutaneous wound has always healed by first intention, because the pocketing that occurs at the lower end of the wound in the classic operation is avoided and hence soiling by tracheal secretions does not occur. By this method, retraction of the isthmus of the thyroid gland without injury is facilitated; high tracheotomy is possible; tissues which must be invaded in a secondary operation are not disturbed; closure of the tracheal wound after need for the tube is over is rapid, and the superficial scar is almost invisible.

DENNIS, San Diego, Calif.

REGARDING DYSPHAGIA IN LARYNGEAL TUBERCULOSIS. ALEXANDER ILJISCH, Monatschr. f. Ohrenh. **73**:369 (June) 1939.

On the basis of the experiment of Rethi on the act of swallowing, the author explains the production of dysphagia as a result of infiltration of the false cords.

In swallowing, the cords are shortened and thickened, and no doubt the false cords act likewise. This change in the structure of the false cords associated with a tearing of the underlying arytenoid gland of Morgagni can at times produce pain in swallowing, although ulcerations are absent. In cases of ulceration of the false cords, pain is observed when the infiltrated areas approximate each other. The prognosis of dysphagia caused by infiltration of the false cords is good, as the lesions can be influenced by treatment (although no details of therapy are discussed by the author).

LEDERER, Chicago.

AN OPEN, BENT SAFETY PIN IN THE ESOPHAGUS. G. CLAUS, Monatschr. f. Ohrenh. **73**:669 (Oct.) 1939.

From a 23 years old woman, a double-twisted, open safety pin was removed by covering the upward turned point with the introduced endoscope.

LEDERER, Chicago.

Nose

OSTEOMYELITIS OF THE FRONTAL BONE. S. R. SKILLERN, Ann. Otol., Rhin. & Laryng. **48**:392 (June) 1939.

The author discusses the views of others regarding the causation of osteomyelitis, most of them feeling that trauma, either operative or accidental, is a prime factor. Swimming also is regarded as a common cause. The staphylococcus is the organism most frequently found. Skillern believes that in the majority of cases osteomyelitis of the calvarium following surgical intervention on the sinuses is due to inadequate intervention at the original operation. In cases in which involvement of bone is suspected he advocates triweekly roentgen study, recognizing at the same time that roentgen evidence of involvement is about ten days behind the actual process.

It has been the author's experience to find the point of rupture for frontal empyema to be in the roof of the orbital plate rather than at the inner angle of the eye, where it might be expected anatomically because of the dependent areas there.

In frontal sinuses in which the walls are of pure compact bone, the first evidence of osteomyelitis is generally found at the junction of the anterior and posterior walls, as there is always cancellous bone there capable of spreading the infection.

The author feels that conservatism should be the rule in acute disease of the frontal sinus until the temperature and other acute symptoms subside, provided that intranasal drainage has been established without incision. If, on the other hand, the pressure in the sinus is so great as to demand surgical drainage, he feels that a small trephine opening predisposes to osteomyelitis as the opening is in constant contact with the secretions, and he feels that if sufficient bone is removed to clean out the entire cavity the chances of complications are less. After this the remaining bone may be removed in a clean field.

The great bulk of the venous drainage of the skull pierces the inner table and empties into the meningeal vessels and blood sinuses; thus any infective exudate reaching these channels may produce thrombophlebitis of the efferent diploic channels and by retrograde thrombosis infect the bone.

It has been shown at autopsy that septic thrombosis in a vein may cause an exudate over the dura far in advance of any evidence of infection in the bone, thus proving that changes on the dura are not simply secondary to diseases of the bone.

Most of the cranial vault gets its blood supply from the meningeal arteries, which supply the dura and send a dense network through the internal table to supply the bone; little enters the bone from the external periosteum. Because of this it is easily seen that a swelling or an exudate on the dura may cut off the blood supply to the calvarium, and it explains why in some cases the inner plate may alone be involved.

Because the veins of the mucosa of the frontal sinus communicate directly with the dural veins, septic thrombosis of these vessels may readily distribute the infection to the dura, brain or skull. This seems to explain why the frontal sinus produces osteomyelitis and abscess of the brain in more cases than do all the other sinuses combined. Low grade infections, however, such as are present in chronic involvement, produce osteogenesis and thicken the walls of the sinus, sometimes even obliterating the cavity, and by this thickening of bone prevent intracranial involvement. Acute exacerbation of a chronic infection may produce osteonecrosis in thickened bone, and, if this can be checked before invasion of new tissue occurs, the thickened bone prevents spreading of the involvement and one has a self-limiting type which responds well to conservative surgical treatment.

The author feels that all frontal sinuses which require operation probably have some extension of the infection and advocates thorough curettage of all softened bone and hemorrhagic osteitis. He does not hesitate to remove the posterior wall of the sinus and expose the dura. He prefers the transeyebrow incision, the elevation of a periosteal skin flap to the limit of the sinuses, the use of a small central trephine for probing, of the Killian V chisel for incising the bone above the superciliary ridge and of rongeurs for the removal of sufficient bone to curet and cleanse the sinal cavities, the treatment of the sinus with an antiseptic bath and then the removal of all the remaining anterior wall. By this procedure the operator can inspect the entire cavity, and if he notes an osteomyelitic area he can attack it according to his best judgment. He feels that it is wise to give preoperative and postoperative transfusions and has found bacterial antigens helpful. If osteomyelitis or abscess of the dura or the brain has necessitated the removal of the posterior wall of the sinus the dura is covered with strips of sheet rubber and these are covered with a single layer of gauze, which is kept saturated every second hour with lysated bacterial fluid. The periosteal skin flap is closed with a drainage tube through the temporal incision. It is routine to place a rubber drainage tube through the enlarged osteum into the nose. When the wound is clean at a secondary operation the author advocates the chipping of small bone flakes from healthy bone and scattering them over the dura as an aid to the development of new bone.

A number of cases are reported, and it is announced that a moving picture film is available to the medical profession on request to the author.

M. V. Miller, Philadelphia.

Discussion on Antral Infection of Dental Origin. Proc. Roy. Soc. Med. **32**:1015 (June) 1939.

A. T. Pitts stated that there are three ways in which infection of the antrum may arise from a dental cause:

1. As the result of chronic dental infection.

2. As the result of acute dental infection.

3. As the result of an accident in the course of dental treatment whereby the antrum is opened.

He expressed the opinion that the first two ways are uncommon and that the great majority of infections occur when the antrum is opened in the course of extraction or when a tooth or a root is pushed into the antrum during a dental operation. In the latter case if simple efforts are not successful in removing the tooth or root the patient should be sent to a rhinologist for operative removal.

E. A. Hardy cited statistics showing that antral disease has been attributed to oral rather than nasal origin in 8 to 50 per cent of cases. He described a method of closing the alveolar fistula by use of a plastic flap.

A. J. Wright discussed further the etiology and pathology of antral infection as related to dental conditions. He expressed the opinion that ascending alveolar osteitis is responsible in many cases for antral infection. The various possible methods of treatment were also discussed briefly.

E. D. Davis commented on the origin of antral infection, particularly in relation to the loss of a root or tooth in the sinus. He expressed opposition to enlarging the opening in the alveolus to remove the root or tooth for fear of a fistula's developing.

H. S. Stones expressed the opinion that the possibility of infection of the antrum in chronic paradontal infections is rather remote.

W. A. Mill stated that in his experience infections of the teeth were not common as a cause of antral infection. CAMPBELL, Philadelphia.

Miscellaneous

NONSURGICAL TREATMENT OF DISEASES OF THE NOSE AND PHARYNX. GORDON D. HOOPLE, Ann. Otol., Rhin. & Laryng. **48**:73 (March) 1939.

The literature of the past five years is reviewed. Emphasis is placed on conservative treatment of acute sinusitis, the minimum intranasal traumatism during the acute stages being advocated. The author also calls attention to the frequency of an unrecognized systemic condition underlying the nasal condition. Rest, elimination, heat and diet are stressed. M. V. MILLER, Philadelphia.

DERMATOLOGIC CONDITIONS OF THE EAR, NOSE AND THROAT. FREDERICK A. FIGI, Ann. Otol., Rhin. & Laryng. **48**:81 (March) 1939.

Dermatologic conditions of the ear, nose and throat may be entirely local processes, but more commonly they are local manifestations of some systemic condition. Various local conditions are mentioned, arising from dyscrasias of the blood (such as anemia, leukemia and achlorhydric anemia), from infections (such as typhoid fever, tularemia, tuberculosis and syphilis) and from fungi. They are of interest to otolaryngologists not only because of the therapy but also because of their diagnostic and prognostic importance in general disease.

M. V. MILLER, Philadelphia.

DOES SUBEPITHELIAL EXTENSION OF INFECTION FROM THE UPPER RESPIRATORY TRACT TO THE LOWER OCCUR? AN EXPERIMENTAL STUDY. ROBERT E. VOTAW, Ann. Otol., Rhin. & Laryng. **48**:103 (March) 1939.

Experimental work done on rabbits failed to show definite subepithelial extension from the sinuses to the rest of the respiratory tract. It did show enlargement of lymphoid tissue in the neck and lungs, which seems to argue in favor of a lymphatic route for the infection. M. V. MILLER, Philadelphia.

THE INHIBITORY EFFECT OF SULFANILAMIDE ON WOUND HEALING. EUGENE M. BRICKER and EVARTS A. GRAHAM, J. A. M. A. **112**:2593 (June 24) 1939.

Bricker and Graham conducted a series of experiments on 28 dogs, after satisfactory standardization of their procedure, to determine what inhibitory effect, if any, sulfanilamide may have on the healing of wounds. They used the method of Harvey and his associates in their experiments on the healing of wounds, in which the tensile strength is the indicator of fibroblastic growth. They describe their experiment as follows:

"Healthy stock dogs were used. Sulfanilamide . . . 3 Gm. daily was given for three days prior to operation. This dose ranged between 0.1 and 0.2 Gm. per kilogram of body weight. The drug was given by mouth in 1.5 Gm. doses twice daily. At operation a 2 cm. incision was made into the fundus of the stomach on the anterior surface. The wound was closed with two layers of 000 plain catgut. A blood sample was taken from the treated dogs for sulfanilamide determination. The dogs were killed three, five and seven days after the operation."

The authors present a chart, which shows a decidedly lower curve for the tensile strength in the wounds of the dogs having received sulfanilamide than for that in the wounds of the controls, but after the seventh day the tensile strength rose to nearly that of the control animals. (Harvey and his associates have shown that there is a "lag phase" of three to four days before fibroblastic growth reaches a maximum velocity.) The authors conclude:

"Sulfanilamide, given to dogs in doses comparable to the therapeutic doses used by human beings, has an inhibiting effect on the healing of uninfected incised wounds, as determined by the tensile strength."

GORDON, Philadelphia.

THE VESTIBULAR SYSTEM WITH POSTENCEPHALITIC PARKINSONISM. L. KILENYI, Arch. ital. di otol. **51**:134 (March) 1939.

Kilenyi reports the results of vestibular examination of 26 patients with postencephalitic parkinsonism. The caloric test of Veits-Germán, modified by Kilenyi, was used: With the patient's head inclined 30 degrees forward, 10 cc. of water of 2 C. was injected into the ear during five seconds; the head was left in position for sixty seconds and then inclined backward at the rate of 9 degrees in two seconds. With this technic nystagmus occurs after a latency of two to three seconds and lasts sixty to ninety seconds. Each patient was submitted to three examinations at intervals of two or three days, the average values of the last two examinations being used to control those of the first examination. In no case was hyperexcitability or bilateral inexcitability observed. In 23 per cent of cases monolateral inexcitability was noted; in 46 per cent, bilateral hypoexcitability; in 46 per cent, monolateral hypoexcitability, and in 15 per cent, bilateral normal excitability. (Bilateral hypoexcitability in 1 and monolateral hypoexcitability in 2 of these were observed at the last examination.) The absence of cochlear symptoms and of obvious lesions of the drum membrane indicates a lesion of the central vestibular pathways. The hypoexcitability observed points to a more or less complete interruption in the central course of the vestibular pathways, perhaps localized in the vestibulomesencephalo-oculogyric neuron. The state of vestibular excitability has no homolateral or heterolateral relation with the postencephalitic manifestations, and there is no correspondence between improvement of the hypoexcitability and objective improvement of the symptoms of the disease.

DENNIS, San Diego, Calif.

TRYPAFLAVINE [ACRIFLAVINE HYDROCHLORIDE]. R. SCHNITZER, Prac. oto-rhino-laryng. **2**:97 (April) 1939.

The author discusses acriflavine hydrochloride as a chemical agent against both bacterial and protozoan infections. It can be used either alone or in combination with other drugs and has shown excellent results in a large series of experimental studies on mice. He suggests further experiments and observations on human beings.

PERSKY, Philadelphia.

Book Reviews

The Art of Anaesthesia. By Paluel J. Flagg, M.D., Anesthetist, New York. Sixth Edition. Price, $6. Pp. 491, with 161 illustrations. Philadelphia, London, Montreal: J. B. Lippincott Co., 1939.

This edition is fully up to the high standard of the previous editions in all phases of the subject and abreast of the times in the fast changing field of modern anesthesia.

While maintaining the simplicity and readability which made the other editions understandable by any one interested in anesthesia, the author gives revised and full discussions of the newer agents and the methods of their administration; at the same time, he does not neglect the older agents and methods. All of the agents are covered, the advantages as well as the disadvantages of each being given.

One of the present day problems is the choice of the agent for a selected surgical procedure; the author considers this phase in more detail than he did formerly.

The many seemingly small points that enter into a consideration of modern anesthesia, such as premedication, position of the patient and after-care of anesthetized patients, are clearly pointed out.

This new edition will be of great help to the inexperienced, as well as the experienced, anesthetist.

News and Comment

AMERICAN BOARD OF OTOLARYNGOLOGY EXAMINATION

The American Board of Otolaryngology will hold an examination at the Manhattan Eye, Ear and Throat Hospital, New York, June 3, 4 and 5, 1940.

Directory of Otolaryngologic Societies *

FOREIGN

Collegium Oto-Rhino-Laryngologicum Amicitiæ Sacrum

President: Dr. Louis Ledoux, Brussels, Belgium.

Secretary: Prof. Dr. C. E. Benjamins, Verlengde Heereweg 143, Groningen, Netherlands.

Hungarian Otolaryngological Society

President: Dr. V. Zimányi, Zárda-u. 48, Budapest II.

Secretary: Dr. G. Kelemen, Reáltanoda-u., Budapest IV.

Sociedad Rioplatense de Oto-Rhino-Laringología (Argentine Section)

President: Dr. Raul Becco, B. Mitre 1690, Buenos Aires.

Secretary: Dr. Juan Manuel Tato, Santa Fé 1171, Buenos Aires.

Société Française d'Oto-Rhino-Laryngologie

Secretary: Dr. Henri Flurin, 19 Avenue Mac-Mahon, Paris, 17e.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. A. W. Proetz, 3720 Washington Blvd., St. Louis.

Secretary: Dr. Leroy A. Schall, 270 Commonwealth Ave., Boston.

Place: New York. Time: June 10-14, 1940.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Frank Brawley, 30 N. Michigan Ave., Chicago.

Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.

Place: Hotel Cleveland, Cleveland. Time: Oct. 6-11, 1940.

American Broncho-Esophagological Association

President: Dr. Lyman Richards, 319 Longwood Ave., Boston.

Secretary: Dr. Paul Holinger, 1150 N. State St., Chicago.

Place: Waldorf-Astoria Hotel, New York. Time: June 5, 1940.

American Laryngological Association

President: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.

Secretary: Dr. Charles J. Imperatori, 108 E. 38th St., New York.

Place: Westchester Country Club, Rye, N. Y. Time: May 27-29, 1940.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President: Dr. Lee M. Hurd, 39 E. 50th St., New York.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.
Place: Waldorf-Astoria Hotel, New York. Time: June 6-8, 1940.

SECTIONS:

Eastern.—Chairman: Dr. John R. Simpson, Medical Arts Bldg., Pittsburgh.
Southern.—Chairman: Dr. Walter J. Bristow, Doctors Bldg., Columbia, S. C.
Middle.—Chairman: Dr. Sam E. Roberts, Professional Bldg., Kansas City, Mo.
Western.—Chairman: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.

AMERICAN OTOLOGICAL SOCIETY

President: Dr. Horace Newhart, 527 Medical Arts Bldg., Minneapolis.
Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.
Place: Westchester Country Club, Rye, N. Y. Time: May 30-31, 1940.